OCTOBER 9, 1959

# electronics

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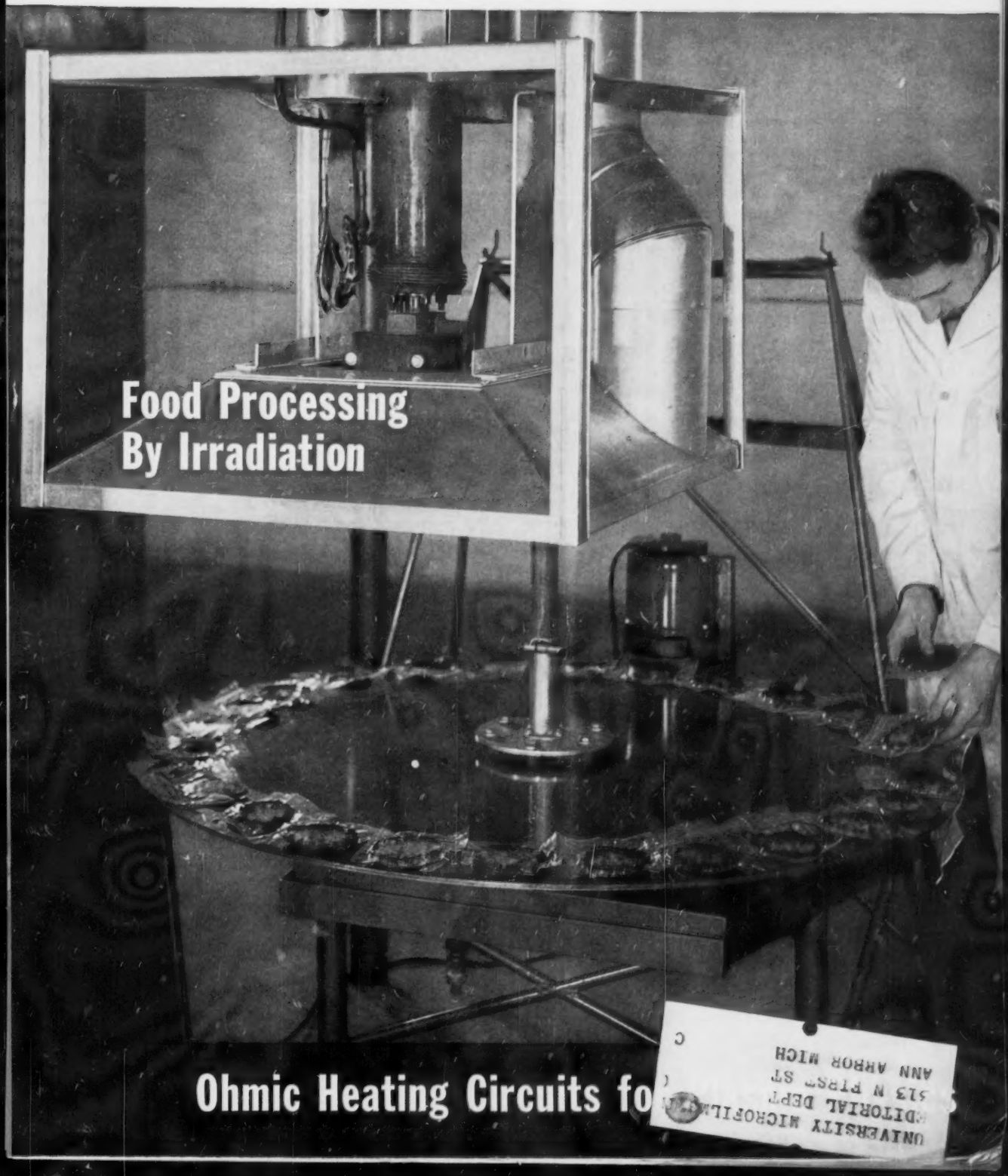

## Food Processing By Irradiation

## Ohmic Heating Circuits fo

UNIVERSITY MICROFILMS
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# FILTERS FOR ALL APPLICATIONS FROM STOCK

HERMETICALLY SEALED TO MIL-T-27A & MIL-F-18327 SPECS.

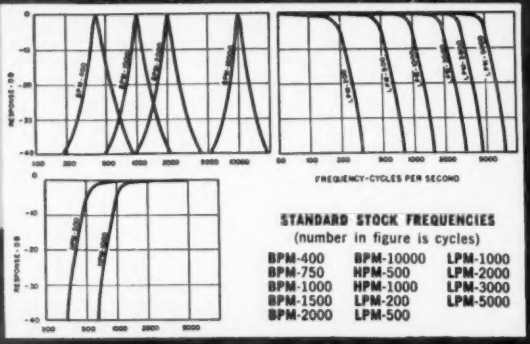
## MINIFILTERS

New Minifilters provide almost the same characteristics (with attenuation only slightly less) as the industry's standard interstage and line filters immediately below.

**BPM** band pass units are 10K input, output to grid; 2:1 gain. Attenuation is approximately 2 db ±3% from center frequency, then 35 db per octave.

**HPM** high pass units; loss of less than 6 db at cut-off frequency; attenuation of 30 db at .67 cut-off frequency, 40 db at .6 cut-off frequency. Input and output 10K.

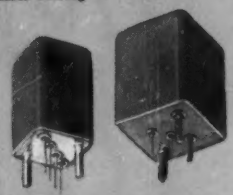
**LPM** low pass units; loss of less than 6 db at cut-off frequency; attenuation of 30 db at 1.5 cut-off frequency, 40 db at 1.65 cut-off frequency. Input and output 10K.




**STANDARD STOCK FREQUENCIES**
(number in figure is cycles)

| | | |
|---|---|---|
| BPM-400 | BPM-10000 | LPM-1000 |
| BPM-750 | HPM-500 | LPM-2000 |
| BPM-1000 | HPM-1000 | LPM-3000 |
| BPM-1500 | LPM-200 | LPM-5000 |
| BPM-2000 | LPM-500 | |

Write For NEW Catalog



BPM case (MIL AF) ⅝ x ⅝ x 1¼" Weight....1 oz.

HPM and LPM case (MIL AS) 1 x 1 x 1¾" Weight....2¼ oz.

## INTERSTAGE & LINE

These six basic types cover most popular filter applications and frequencies.

**BMI** band pass units are 10K input, output to grid; 2:1 gain. Attenuation is approximately 2 db at 3% from center frequency, then 40 db per octave.

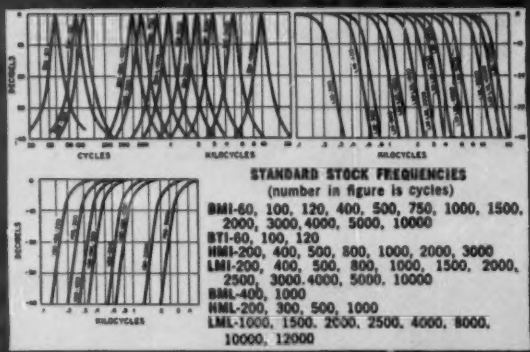
**HMI** high pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at .67 cut-off frequency.

**LMI** low pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at 1.5 cut-off frequency.

**HML** high pass filters are same as HMI but 500/600 ohms in and out.

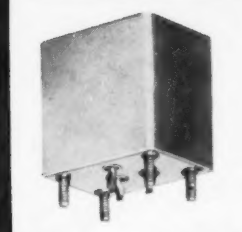
**LML** low pass filters are same as LMI but 500/600 ohms in and out.

**BML** band pass units are same as BMI but 500/600 ohms input, output to grid, 9:1 gain.




**STANDARD STOCK FREQUENCIES**
(number in figure is cycles)

BMI-60, 100, 120, 400, 500, 750, 1000, 1500, 2000, 3000, 4000, 5000, 10000
BTI-60, 100, 120
HMI-200, 400, 500, 800, 1000, 2000, 3000
LMI-200, 400, 500, 800, 1000, 1500, 2000, 2500, 3000, 4000, 5000, 10000
BML-400, 1000
HML-200, 300, 500, 1000
LML-1000, 1500, 2000, 2500, 4000, 8000, 10000, 12000



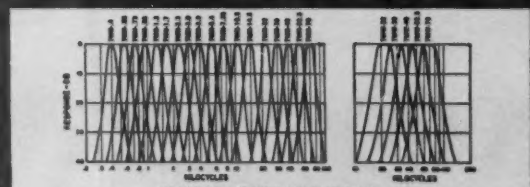
Base ..... 1¾ x 1¼"
Height, BMI, LMI, BML ..... 1⅝"
Height, HMI, HML, LML ..... 2½"
Weight ..... 6 oz. and 9 oz.

## TELEMETERING BAND PASS

UTC standard telemetering filters provide extreme miniaturization with maximum stability, a complete set of 18 filters taking 19 cubic inches. They are 100K in and out and have an insertion loss of less than 6 db, 4 pin header for small Winchester socket.

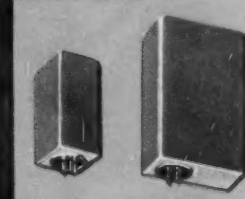
**TMN** units are within 3 db at ± 7.5% of center frequency . . . down more than 18 db at ± 25% . . . more than 40 db beyond 1.75 and .58 center frequency.

**TMW** are within 3 db at ± 15% of center frequency . . . down more than 20 db at ± 50% . . . more than 40 db beyond 2.5 and .4 center frequency.




**STANDARD STOCK FREQUENCIES**
(number in figure is KC)

| | | | | |
|---|---|---|---|---|
| TMN- .4 | TMN-1.7 | TMN- 5.4 | TMN-30 | TMW-22 |
| TMN- .56 | TMN-2.3 | TMN- 7.35 | TMN-40 | TMW-30 |
| TMN- .73 | TMN-3.0 | TMN-10.5 | TMN-52.5 | TMW-40 |
| TMN- .96 | TMN-3.9 | TMN-14.5 | TMN-70 | TMW-52.5 |
| TMN-1.3 | | TMN-22 | | TMW-70 |



TMN-2.3 thru TMW-70 ⅝ x ⅝ x 1¾" Weight....1.2 oz.

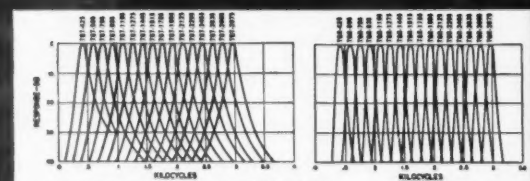
TMN-.4 thru TMN-1.7 1⅛ x 1⅝ x 2" Weight....3.5 oz.

## TELEGRAPH TONE CHANNEL

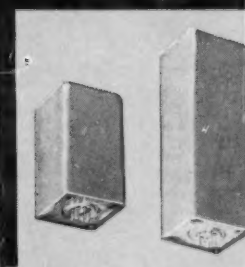
These band pass filters for multiplex transmitting and receiving provide maximum stability in miniature sizes. Both receiving and transmitting types are 600 ohms in and out, and employ 7 terminal header for sub-miniature 7 pin socket.

**TGT** transmitting filters are within 3 db at ± 42.5 cycles from center frequency . . . down more than 16 db at ± 170 cycles . . . down more than 7.5 db at adjacent channel crossover.

**TGR** receiving filters are within 3 db at ± 42.5 cycles from center frequency . . . down more than 30 db at ± 170 cycles . . . down more than 15 db at adjacent channel crossover.




| TRANSMITTING | | STANDARD STOCK FREQUENCIES (number in figure is cycles) | RECEIVING | |
|---|---|---|---|---|
| TGT-425 | TGT-1785 | | TGR-425 | TGR-1785 |
| TGT-595 | TGT-1955 | | TGR-595 | TGR-1955 |
| TGT-765 | TGT-2125 | | TGR-765 | TGR-2125 |
| TGT-935 | TGT-2295 | | TGR-935 | TGR-2295 |
| TGT-1105 | TGT-2465 | | TGR-1105 | TGR-2465 |
| TGT-1275 | TGT-2635 | | TGR-1275 | TGR-2635 |
| TGT-1445 | TGT-2805 | | TGR-1445 | TGR-2805 |
| TGT-1615 | TGT-2975 | | TGR-1615 | TGR-2975 |



TGT CASE 1½ x 1½ x 2¼" Weight....8 oz.

TGR CASE 1½ x 1½ x 4¼" Weight....15 oz.

*And Special Units to Your Specifications*

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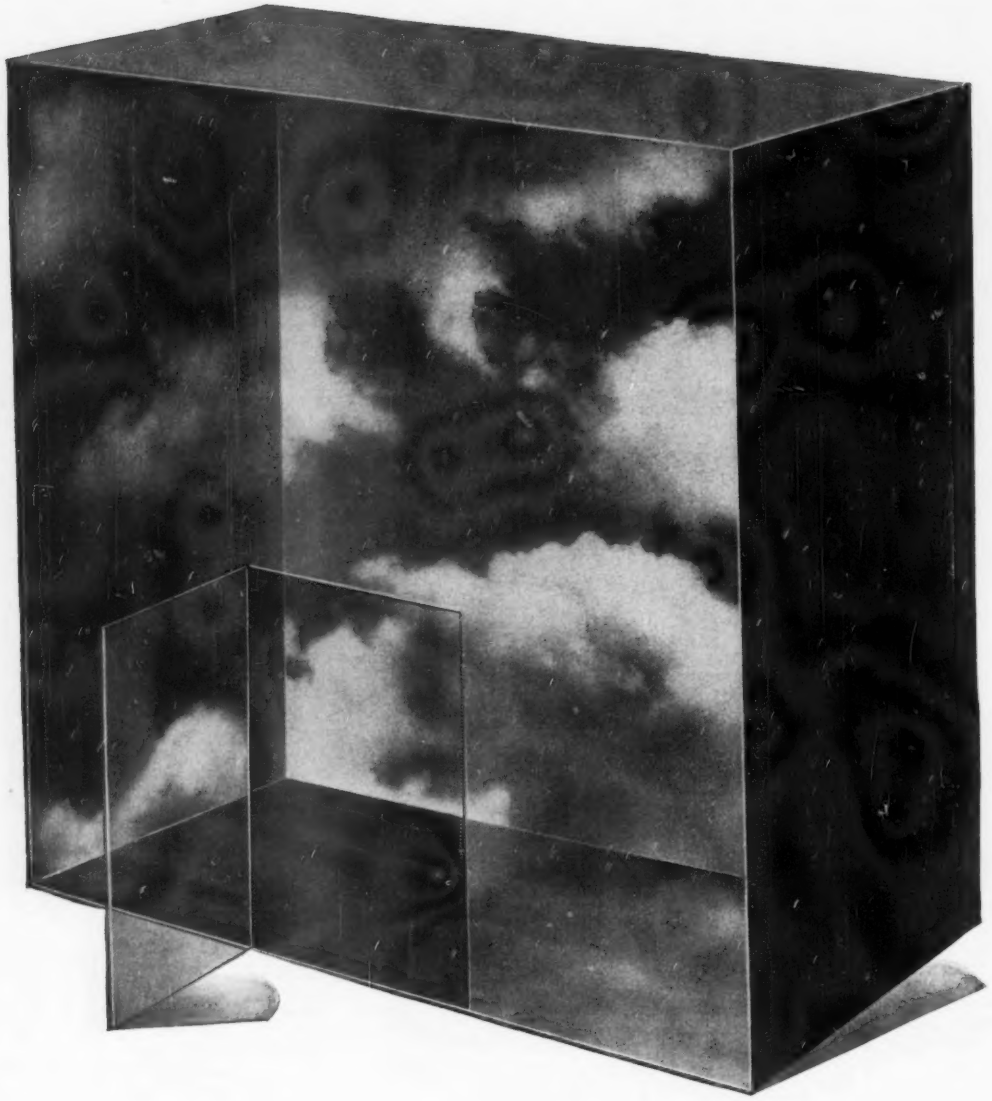

# Bring the wild blue yonder indoors...

If you have to figure what happens up there . . . you'll come considerably closer by testing with B.F.Goodrich Microwave Absorbents. The specifications and details are many. Sufficient to say—*all* the information is in a comprehensive new booklet. Write to The B.F.Goodrich Company, 586 Derby Place, Shelton, Connecticut.

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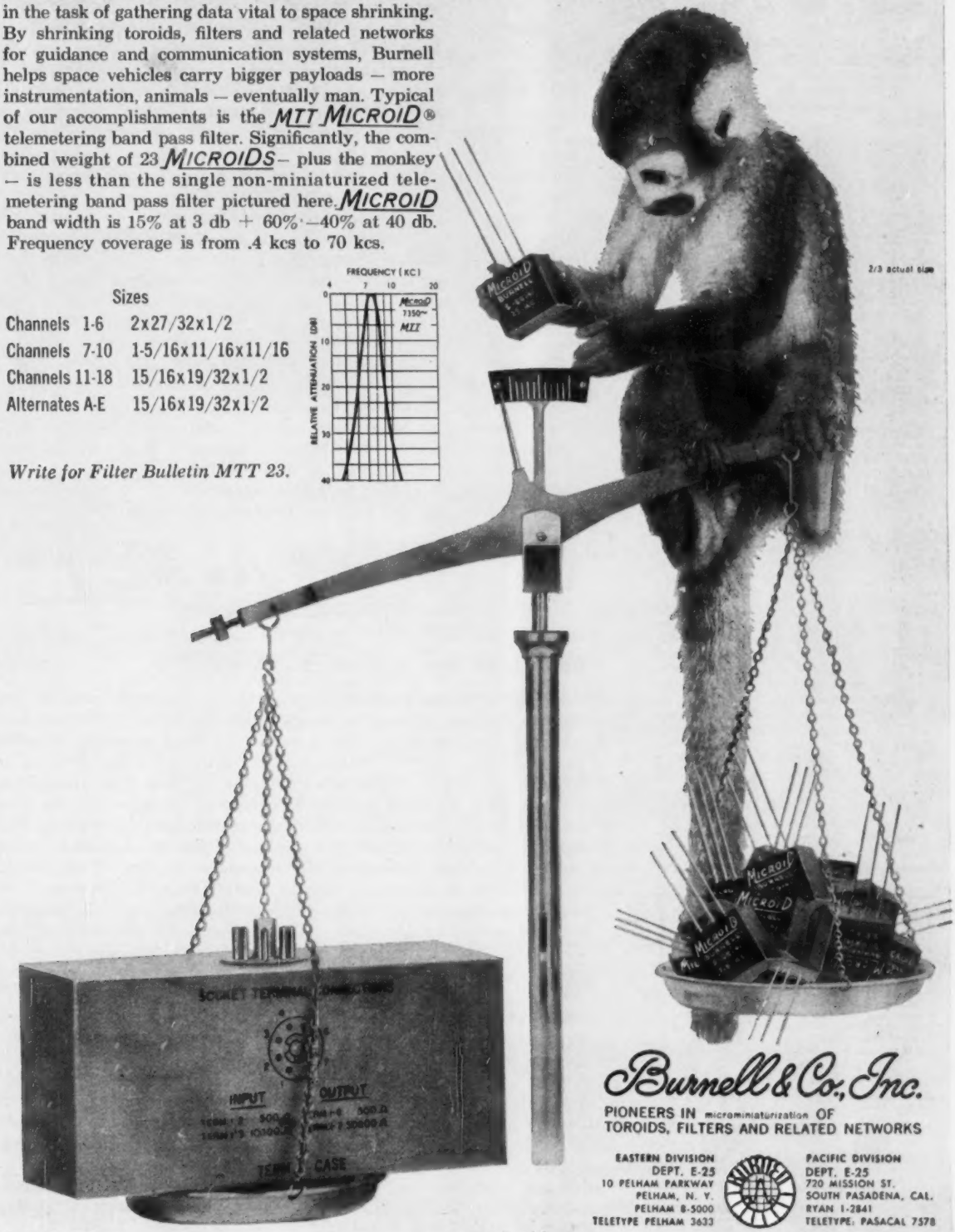
# SPACE SHRINKERS

**MICROIDS AND MONKEYS**—Burnell & Co. welcomes the assistance of their simian friends in the task of gathering data vital to space shrinking. By shrinking toroids, filters and related networks for guidance and communication systems, Burnell helps space vehicles carry bigger payloads — more instrumentation, animals — eventually man. Typical of our accomplishments is the MTT MICROID® telemetering band pass filter. Significantly, the combined weight of 23 MICROIDS — plus the monkey — is less than the single non-miniaturized telemetering band pass filter pictured here. MICROID band width is 15% at 3 db + 60% —40% at 40 db. Frequency coverage is from .4 kcs to 70 kcs.

| Sizes | |
|---|---|
| Channels 1-6 | 2x27/32x1/2 |
| Channels 7-10 | 1-5/16x11/16x11/16 |
| Channels 11-18 | 15/16x19/32x1/2 |
| Alternates A-E | 15/16x19/32x1/2 |

*Write for Filter Bulletin MTT 23.*

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# SHOPTALK . . . editorial

**THE ELECTRONICS INDUSTRY.** Nearly thirty years ago, this magazine gave its name to an infant industry. Today, the electronics industry encompasses more than 4,000 plants that employ nearly 2 million workers. And people still ask: "What is electronics?"

Electronics is an art and a science and an industry concerned with the motion of charged particles. This motion is ordered and put to work in electron devices such as tubes, transistors, magnetic amplifiers, masers, and a host of other solid, liquid or gaseous contrivances.

The development, manufacture and use of electron devices, the equipment in which they are used, the components and hardware that are used with them, and special materials from which these things are made are all part of the electronics industry.

In many plants electronic equipment, materials or components make up almost all the output. In other plants electronic products make up less than all the output: a machine shop punches out chassis, an airframe manufacturer makes inertial guidance systems, a chemical manufacturer rolls printed-circuit board stock. These too are part of the electronics industry to the extent that they are manufacturing electronic equipment, components or materials.

The degree of specialization varies. Some airframe manufacturers may realize 50 to 60 percent of their gross sales in electronic equipment and parts. An automobile manufacturer may be 5 to 10 percent in electronics. Few large firms are exclusively in electronics.

ELECTRONICS, interest in its industry transcends classifications based on major product of any manufacturer. Where people are designing, making or using electronic materials, components or equipment, there is our industry and our editorial interest.

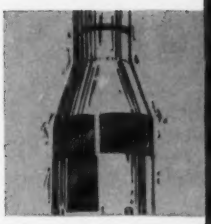
W W MacDonald

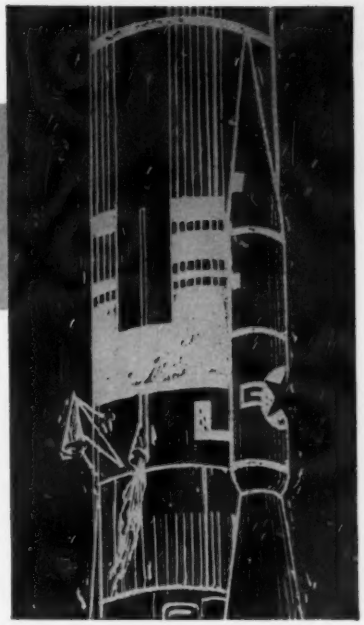
*Editor*

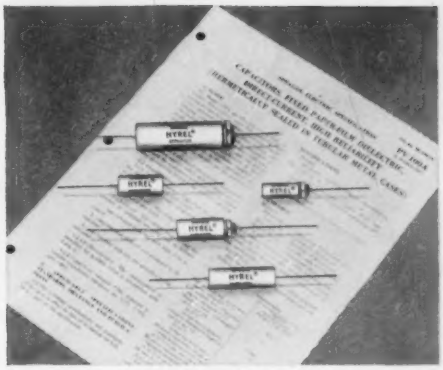
## Coming In Our October 16 Issue . . .

**INSTRUMENTING HUMAN PAYLOADS.** A capsule shaped like the one designed to carry a human cargo for Project Mercury was recently recovered intact after a successful flight down the Atlantic Range. This is another significant step toward the inevitable first human space flight. When this epochal event does take place, how will scientists on earth monitor the physical wellbeing of the first astronaut? The problems of instrumentation for determining the physiological data under conditions of space flight are indeed complex and require new and ingenious transducer design. Next week, M. Traite, W. Welkowitz, J. Kilduff and C. Purporo of the medical instruments department of Gulton Industries, Metuchen, N. J., describe both the transducers and associated circuitry for determining the respiration, electrocardiogram, temperature, blood pressure and other physical parameters of men, in space.

**PRECISION ANGLE ENCODER.** Accurate, automatic measurement of angular position is needed for optically guided missile-tracking instruments. A special angle transducer of unusual design and construction has recently been developed which allows real-time digital recording of shaft position of special radars and optical tracking instruments. L. G. DeBey of Aberdeen Proving Ground, D. Comstock of the Norden division of United Aircraft, and S. B. Peterson and R. C. Webb of Colorado Research Corp. have teamed up to describe this new transducer and associated electronics. The vernier element introduces a new principle into analog-to-digital conversion: quantization by radio interferometry.







# MISSILE-READY CAPACITORS
## —thanks to Sprague's PV-100A

It has been more than three years since Sprague originated Specification PV-100–*the first high reliability capacitor specification for missiles and other critical applications.* This specification and a later revision, PV-100A, have proved so comprehensive and so successful in providing "the highest order of reliability known to the capacitor industry" that their provisions are currently reflected in *every* military specification covering high reliability capacitors. This is a distinction shared by no other capacitor manufacturer.

The capacitors manufactured by Sprague to PV-100 and PV-100A standards have amassed a record of reliability far in excess of original expectations. On high frequency vibration, shock, and other environmental tests, failure rate has been almost zero. On accelerated life tests (250 hours at 140% rated voltage, 125° C) *failure rate has been less than .05%.* This performance is virtually impossible to beat . . . now and for some years to come. But Sprague doesn't stop here. The company's research on materials, processes, and controls is now more intensive than ever. Sprague knows that only through continuous research can high reliability be made *higher.*

If you're interested in the fine points of high reliability capacitors, call your Sprague District Office or Representative. Or write letterhead request for Sprague's Hyrel Bulletin 2900A and Specification PV-100A to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Mass.

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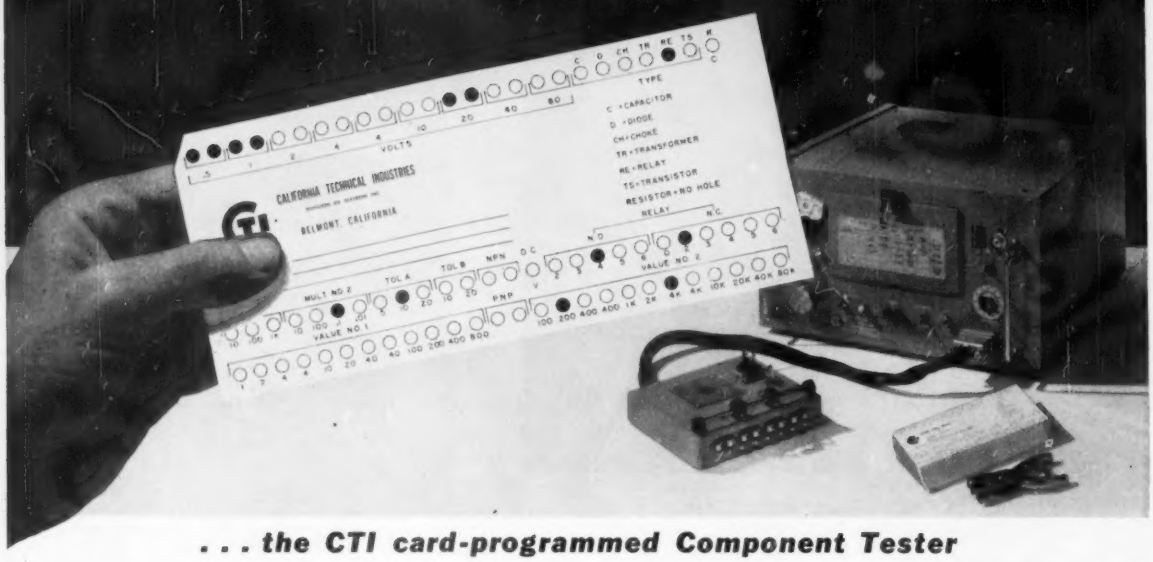
*A revolutionary approach to*

# INCOMING INSPECTION . . .




## . . . the CTI card-programmed Component Tester

Reduce your incoming-test procedures to the insertion of a card and the push of a button! Large quantities or varied, small lots of any of the basic electronic components can be handled with equal efficiency by the CTI Component Tester. An unskilled operator merely selects the appropriate card. The Component Tester performs the required series of tests and indicates either that the component has passed or the type of failure that has been found. "Over", "under", and "pass" circuits are provided for completely automatic operation with handling and sorting devices.

The simplicity of operation and surprisingly low cost of this instrument are the result of CTI's extensive experience in the field of automatic testing. An ingenious card reader provides both reliability and economic design. Precision bridge measurements and fail-safe circuitry are features gained in the development of CTI's automatic circuit testers.

Programming is accomplished with an ordinary hand punch. A single hole selects one of the test sequences listed below. Several additional holes dictate specific values and tolerances. Combinations or modifications of these standard tests can be used for special measurements.

**CAPACITORS**

Capacity: .002 to 100 mfd; smaller values using external oscillator
Leakage or Shunt Resistance Limit: 1 ohm to 1.62 megohms at 6 volts d-c, or 50 megohms at 100 v d-c

**TRANSISTORS**

Cut-off Current ($I_{co}$): 0.375 microamperes to 1 amp
A-C Current Gain (base to collector—emitter common): 10 to 100

**CHOKES**

Inductance with rated D-C Current flowing: .03 to 50 henries: 0.5 to 161 ma
D-C Winding Resistance: 1 ohm to 1.62 megohms
Leakage Resistance Limit from winding to core: 50 megohms

**DIODES and RECTIFIERS**

Forward Resistance at 1 volt: 1 ohm to 1.62 megohms
Reverse Resistance at rated Reverse Voltage: 1 ohm to 1.62 megohms, 1 to 161 volts d-c

**RESISTORS**

Resistance: 1 ohm to 16.2 megohms

**TRANSFORMERS**

Primary Inductance: .03 to 12 henries
Winding Ratio: 1:1 to 100:1
Winding Polarity
Leakage Resistance Limit from winding to core: 50 megohms at 100 v d-c

**RELAYS**

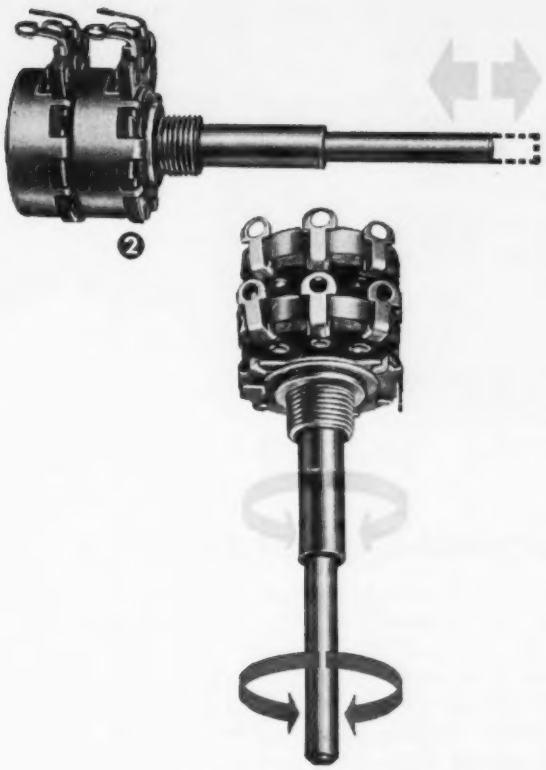
Pull-In Voltage: a-c or d-c, 0.5 to 161 volts
Continuity of each contact when closed: 1 ohm to 1.62 megohms
Leakage Resistance Limit between contacts in open position: 50 megohms at 100 v d-c
Coil Resistance: 1 ohm to 16.2 megohms
Leakage Resistance Limit from coil to frame: 50 megohms at 100 v d-c
Leakage Resistance Limit from all swingers and fixed contacts to frame: 50 megohms at 100 v d-c

Engineers: Career opportunities are currently available at CTI

CALIFORNIA TECHNICAL INDUSTRIES
DIVISION OF TEXTRON INC.
BELMONT 8, CALIFORNIA
*Foremost in Automatic Testing*

# NEW CONTROLS FOR STEREO

### *Flexibility without Complexity*



Even a wife can appreciate the major points of these special dual-element controls for 2-channel stereo equipment! No longer is it necessary to fiddle with 2 bass controls, 2 treble controls, and 2 volume controls to obtain proper stereo balance—then re-adjust everything when listening to monophonic material. No longer, that is, unless you're an ardent audiophile who would have it no other way.

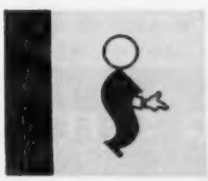
For these new Stackpole controls "clean-up" the panels of stereo equipment, make them easier to operate and understand . . . yet retain all the flexibility of individual adjustments required on the most elaborate equipment.

❶ **FRICTION SHAFT DUAL**—Type LS3: A friction fit between shafts causes both elements of this dual concentric shaft control to operate in tandem when either shaft is turned. Either element can also be adjusted independently by holding one shaft while rotating the other. Once set, either knob can be turned while maintaining stereo balance through a wide range of adjustment.

❷ **CLUTCH SHAFT DUAL**—Type LS1: This wonderfully convenient control allows either simultaneous or individual adjustment of its two elements. A push on the inner shaft engages a clutch which connects both elements together for tandem operation by either shaft. Pulling the inner shaft permits each element to be individually adjusted without disturbing the other.

❸ **MATCHED ELEMENT TANDEM**—Type L-Tandem: Through precise electrical matching and careful mechanical alignment, this stereo tandem control allows convenient, single-knob adjustment of both channels. It's ideal for adjustment of master volume or of bass or treble in systems where an absolute minimum of panel complexity is desired.

**STACKPOLE**



Colditz 70+® fixed composition Resistors • Slide & Snap Switches • Ceramag® Ferrite Cores • Fixed composition Capacitors • Ceramagnet® Ceramic Magnets • Electrical Contacts • Brushes for all rotating electrical equipment • Hundreds of related carbon, graphite, and metal powder products.

*Mechanical and electrical specifications on these dependable 0.75-watt variable composition resistors are available on request. Electronic Components Division, Stackpole Carbon Company, St. Marys, Pa.*

# NOW!

**Constant output level**

**Constant modulation level**

**3 volt output into 50 ohms**

**Low envelope distortion**

# 50 kc to 65 MC

## NEW -*hp*- 606A HF Signal Generator

Here at last is a compact, convenient, moderately-priced signal generator providing constant output and constant modulation level plus high output from 50 kc to 65 MC. Tedious, error-producing resetting of output level and % modulation are eliminated.

Covering the high frequency spectrum, (which includes the 30 and 60 MC radar IF bands) the new -*hp*- 606A is exceptionally useful in driving bridges, antennas and filters, and measuring gain, selectivity and image rejection of receivers and IF circuits.

Output is constant within ±1 db over the full frequency range, and is adjustable from +20 dbm (3 volts rms) to —110 dbm (0.1 μv rms). No level adjustments are required during operation; the instrument has a minimum of controls and high accuracy results are assured due to the constant internal impedance. The generator can be provided with a 10:1 voltage divider and dummy antenna lowering minimum output to 0.01 μv (from 5 ohms) and simulating IRE standards for precision receiver measurements. (See Accessories Available in Specifications.)

The new -*hp*- 606A may be modulated by sine waves and complex waveforms from dc to 20 KC. A meter indicates percent modulation. Distortion in sine waves is extremely low due to use of a feedback circuit.

To insure maximum accuracy of frequency setting, the 606A includes an internal crystal calibrator providing check points at 100 kc and 1 MC intervals with error less than 0.01%.

**hp offers the world's most complete**

# Specifications

**Frequency Range:** 50 kc to 65 MC in 6 bands.

| | |
|---|---|
| 50— 170 kc | 1.76— 6.0 MC |
| 165— 560 kc | 5.8 —19.2 MC |
| 530—1800 kc | 19.0 —65.0 MC |

**Frequency Accuracy:** Within ±1%.

**Frequency Calibrator:** Crystal oscillator provides check points at 100 kc and 1 MC intervals accurate within 0.01% from 0° to 50° C.

**RF Output Level:** Continuously adjustable from 0.1 μv to 3 volts into a 50 ohm resistive load. Calibration is in volts and dbm (0 dbm is 1 milliwatt).

**Output Accuracy:** Within ±1 db into 50 ohm resistive load.

**Frequency Response:** Within ±1 db into 50 ohm resistive load over entire frequency range at any output level setting.

**Output Impedance:** 50 ohms, SWR less than 1.1:1 at 0.3 v and below. BNC Output connector mates with UG-88A/B/C/D.

**Spurious Harmonic Output:** Less than 3%.

**Leakage:** Negligible; permits sensitivity measurements down to 0.1 μv.

**Amplitude Modulation:** Continuously adjustable from 0 to 100%. Indicated by a panel meter. Modulation level is constant within ±½ db regardless of carrier frequency.

**Internal Modulation:** 0 to 100% sinusoidal modulation at 400 cps ±5% or 1000 cps ±5%.

**Modulation Bandwidth:** Dc to 20 kc maximum, depends on carrier frequency, $f_c$, and percent modulation as shown in the following table:

| | *30% Mod.* | *70% Mod.* | *Squarewave Mod.* |
|---|---|---|---|
| Max. Mod. Frequency | 0.06 $f_c$ | 0.02 $f_c$ | 0.003 $f_c$ (3 kc max) |

**External Modulation:** 0 to 100% sinusoidal modulation dc to 20 kc. 4.5 volts peak produces 100% modulation at modulating frequencies from dc to 20 kc. Input impedance is 600 ohms. May also be modulated by square waves and other complex signals.

**Envelope Distortion:** Less than 3% envelope distortion from 0 to 70% modulation at output levels of 1 volt or less.

**Modulation Meter Accuracy:** Within ±5% of full scale reading from 0 to 90%.

**Spurious FM:** 0.0025% or 100 cps, whichever is greater, at an output of 1 v or less and 30% AM modulation.

**Spurious AM:** Hum and noise sidebands are 70 db below carrier.

**Power:** 115/230 volts ±10%, 50 to 1000 cps, 135 watts.

**Accessories Available:** *-hp-* AC-606A-34 Output Voltage Divider with 50 and 5 ohms termination (10:1 voltage divider) and IRE standard dummy antenna (10:1 voltage divider). $50.00.

**Price:** (cabinet) $1,200.00. (rack mount) $1,185.00.

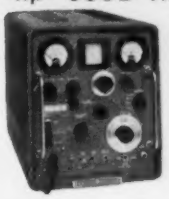
*Data subject to change without notice. Prices f.o.b. factory.*

## Other -hp- Signal Generators—10 to 21,000 MC

| Instrument | Frequency Range | Characteristics | Price |
|---|---|---|---|
| *-hp-* 608C | 10 to 480 MC | Output 0.1 μv to 1 v into 50 ohm load. AM, pulse, or CW modulation. Direct calibration | $1,000.00 |
| *-hp-* 608D | 10 to 420 MC | Output 0.1 μv to 0.5 v. Incidental FM 0.001% entire range | 1,100.00 |
| *-hp-* 612A | 450 to 1,230 MC | Output 0.1 μv to 0.5 v into 50 ohm load. AM, pulse, CW or square wave modulation. Direct calibration | 1,200.00 |
| *-hp-* 614A | 800 to 2,100 MC | Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration | 1,950.00 |
| *-hp-* 616A | 1,800 to 4,000 MC | Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration | 1,950.00 |
| *-hp-* 618B | 3,800 to 7,600 MC | Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW, FM or square wave modulation. Direct calibration | 2,250.00 |
| *-hp-* 620A | 7,000 to 11,000 MC | Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, FM or square wave modulation. Direct calibration | 2,250.00 |
| *-hp-* 623B | 5,925 to 7,725 MC | Output 70 μv to 0.223 v into 50 ohm load. FM or square wave modulation. Separate power meter and wave meter section. | 1,900.00 |
| *-hp-* 624C | 8,500 to 10,000 MC | Output 3.0 μv to 0.223 v into 50 ohm load. Pulse, FM or square wave modulation. Separate power meter and wave meter section | 2,265.00Δ |
| *-hp-* 626A | 10 to 15.5 KMC | Output 10 dbm to —90 dbm. Pulse, FM, or square wave modulation. Direct calibration | 3,250.00 |
| *-hp-* 628A | 15 to 21 KMC | Output 10 dbm to —90 dbm. Pulse, FM, or square wave modulation. Direct calibration | 3,250.00 |

ΔRack mounted instrument available for $15.00 less.

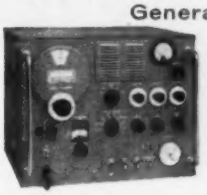
### -hp- 608D vhf Signal Generator



10 to 420 MC. Highest stability. No incidental FM or frequency drift. Calibrated output 0.1 μv to 0.5 v throughout range. Built-in crystal calibrator provides frequency check accurate within 0.01% each 1 and 5 MC. Master-oscillator, intermediate and output amplifier circuit design. Premium quality performance, direct calibration, ideal for aircraft communications equipment testing. $1,100.00.

**-hp- 608C vhf Signal Generator.** High power (1 v max.) stable, accurate generator for lab or field use. 10 to 480 MC. Ideal for testing receivers, amplifiers, driving bridges, slotted lines, antennas, etc. $1,000.00.

### -hp- 626 A/628A shf Signal Generators



New instruments, bringing high power, wide range, convenience and accuracy to 10 to 21 KMC range. Frequencies, output voltage directly set and read. Output 10 to 20 db better than previous spot-frequency sets SWR better than 1.2 at 0 dbm and lower. Internal pulse, FM or square wave modulation; also external pulsing or FM'ing. *-hp-* 626A, 10 to 15.5 KMC, $3,250.00. *-hp-* 628A, 15 to 21 KMC, $3,250.00.

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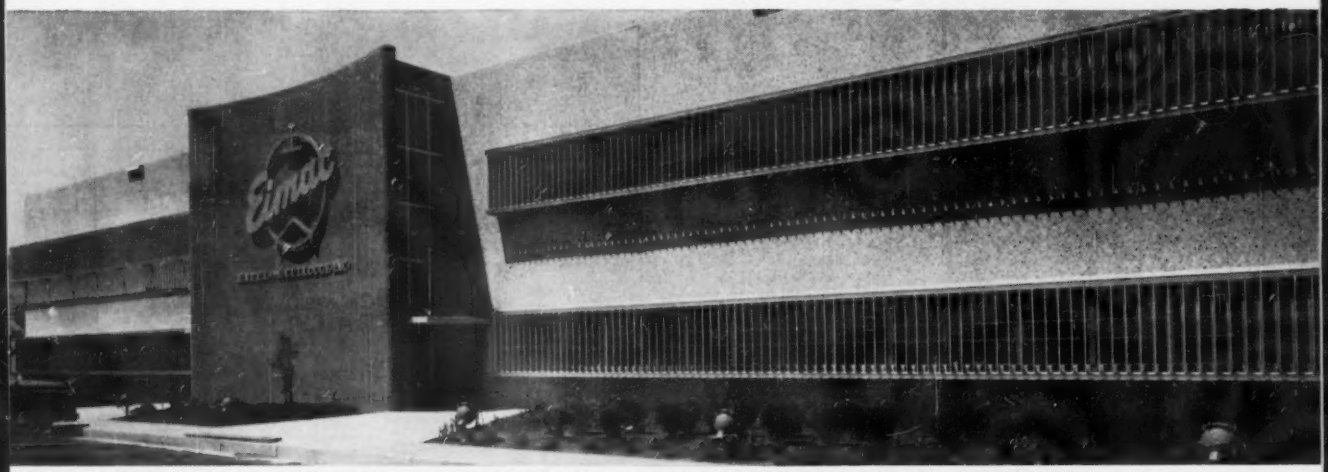
## line of precision signal generators

# EIMAC TUBES
# NOW IN PRODUCTION
# IN AMERICA'S NEWEST, MOST MODERN TUBE PLANT

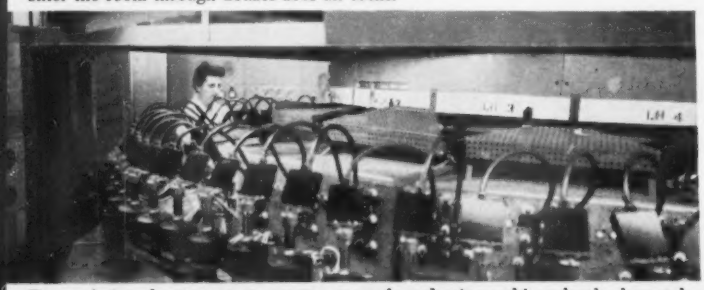
In San Carlos, California, Eimac's third and largest plant is now in full production to meet the great demand for many popular Eimac electron tube families. Never before have so many advanced techniques and processes been applied to vacuum tube manufacture. Eimac's leadership in new processing methods has brought a new era of quality to electron tubes.

*Ready for shipment,* these Eimac ceramic tetrodes are just one of more than a hundred different tube types manufactured by Eitel-McCullough, Inc., including negative grid tubes, power amplifier klystrons, reflex klystrons and traveling wave tubes.




Eimac, San Carlos, greatly increasing production capacity, joins San Bruno and Salt Lake City facilities as Eimac's newest plant.

*Final tube assembly in near-sterile "clean rooms"* assures exceptional tube reliability. These rooms are pressurized with filtered, conditioned air to prevent the tiniest dust particles from entering. Even shoes are automatically vacuum cleaned as personnel enter the room through double-door air locks.



*Eimac designed rotary vacuum pumps speed production,* achieve hard, clean tube vacuums. Pumping Eimac tubes at high voltages and ambient temperatures assures long life and reliability. These giant rotary pumps are typical of production equipment custom designed by Eimac for transmitting tube manufacture.

*Every tube meets rigid Eimac specifications before shipment.* On test consoles like this, dozens of electrical characteristics are patiently tested and recorded for each Eimac tube produced. Environmental testing equipment is also available for testing for severe applications.

**EITEL-McCULLOUGH, INC.**
SAN CARLOS, CALIFORNIA

# ELECTRONICS NEWSLETTER

**DIGITAL COMPUTER USE** in industrial process control receives new impetus with the team-up of RCA and The Foxboro Co. of Foxboro, Mass., big name in industrial instruments and controls. RCA Industrial Electronic Products division is packaging the heart of the input-output processor from its big new 501 computer as a separate model, the 110. The 110 is being sold as a master control unit for industrial production processes. Team hopes to crack the industrial control field by offering to engineer and build control systems in depth.

***Panel meetings on problems in circuit theory, recruiting of scientific personnel and education for leadership in electronics will highlight the 15th annual National Electronics Conference to be held next week in Chicago. More than 13,000 persons are expected to choose from 28 sessions and over 125 papers, plus 282 exhibit booths.***

**NEW GUIDANCE SYSTEM** for missiles and aircraft called PINPOINT combines ATRAN and inertial guidance. ATRAN is the Goodyear Aircraft guidance system, used on the TM-76A Mace missile, which compares the terrain shown on a radarscope with a film strip previously obtained from the scope over the same course. System can then use landmarks such as lakes to correct flight. PINPOINT, just announced by Goodyear as an outgrowth and refinement of ATRAN, is said to correct errors generated by its inertial guidance subsystem, with accuracy independent of both range and velocity of the missile or aircraft.

**FIFTY-MILLION-WATT RADAR** will be designed and manufactured by FXR, Inc. of Woodside, New York, under a $500,000 subcontract from Cornell Aeronautical Laboratory, which has an R&D prime contract from Army Ordnance. CAL's goal of 50 million watts peak power, with a variety of pulse lengths and repetition rates, follows CAL achievement of transmission of 21 million watts of peak power. FXR will make the complete transmitter, which will use a series of amplifier tubes. The tubes will require synchronized frequency of about 3.5 millimicroseconds.

***Theoretical study of an interferometer tracking system is being carried out by Smith Electronics, Cleveland, under a contract from Air Proving Ground Center, Elgin AFB, Fla. System under study will track a telemetry signal in the 2,200-2,300-mc range over a distance of 5,000 mi. It will provide Doppler velocity measurement besides position data.***

**AUTOMOTIVE INDUSTRY** continues electronics expansion. On one hand, electrical equipment suppliers are seeking new product lines. On the other hand, automakers want to improve their cars, often with their own electronic products. In the first category is Electric Autolite, which expects to market a new electronic commutator this fall for about $50. Other new developments: a transistorized inkless recorder, radiation-resistant wire and surface-discharge spark plugs. Autolite is also developing high-temperature ceramics for electronic applications. Chrysler reports that its compact new Valiant will use a Chrysler-made alternator-rectifier unit to provide 12-volt d-c, claims the new unit weighs 12 lb less than a conventional d-c generator of equivalent output. Automaker says the unit provides 10 A output at idle speed and increases brush life through the use of smooth slip rings instead of a serrated commutator. Rectifier transforms 19-cycle a-c to d-c; three silicon diodes permit positive pulses to pass and three others pass negative pulses to provide full wave rectification. System eliminates the current-regulating solenoid. Chrysler hopes to produce at least 200,000 1960-model Valiants, will also use the device in its Imperial model. Ford offers a similar unit on heavy-duty trucks. GM, through its Delco-Remy division, provides its device as an option for fleet owners.

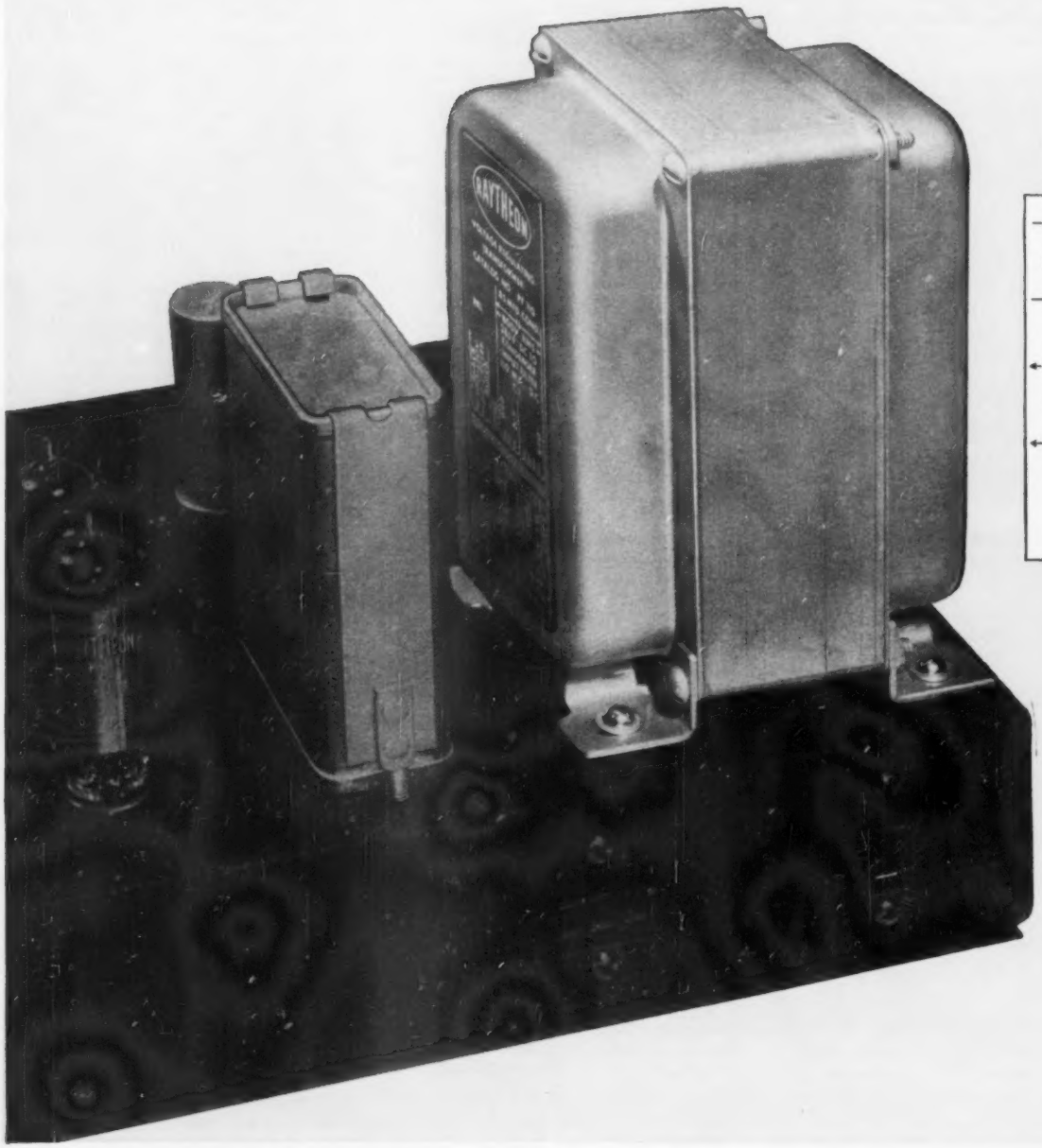
***Solar power system for space satellites, capable of producing 100 watts of electricity continuously and 500 watts peak, will be developed by Hoffman Laboratories, Los Angeles, a division of Hoffman Electronics Corp., under a $600,000 contract from Wright ADC. The large-area panel will be applicable to various space programs.***

**AUTOPILOTS** for the fast-growing business aircraft market get a marketing push with the introduction of a new transistorized unit by Sperry Phoenix division of Sperry Rand. The company expects that business aircraft will number 38,000 by 1965, 95,000 by 1975. Sperry says modular construction of its new autopilot permits a user to install a single axis, later make it a two-axis or complete three-axis flight control system.

**SOVIET OCEANOGRAPHIC SUBMARINE** *Severyanka* (ELECTRONICS, p 19, Sept. 18, p 31, Mar. 20) is equipped with "a depth stabilizing device which enables it to remain at any depth" and an exit chamber through which scientists in diving gear can leave the sub while it lies on the bottom of the sea. This new information was reported in *Tekhnika Molodezhi* by Yu. Kryuchkov.

**ULTRASONIC MACHINE** is bringing home leaner bacon in Britain, where the British Oil and Cake Mills at Barlby, Yorkshire, is using it to determine the suitability of boars as sires before a litter of bacon rasher types has been bred. Waves are sent at right angles to the skin and reflected back from the interface between the underlying fat and muscle with a time lag related to the depth of fat. Lean area can then be determined. Since thickness of outer fat is an inherited characteristic in pigs, boars that would bring home fatty bacon through their progeny are not allowed to breed.

# Raytheon Voltage Regulating
# PLATE-FILAMENT



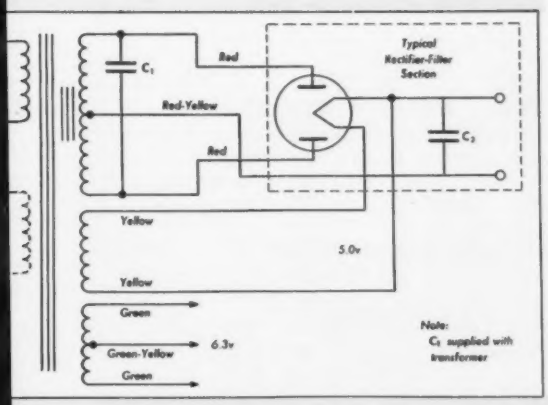
# TRANSFORMERS . . . . . .

## Transformers that regulate voltage to within ± 3%

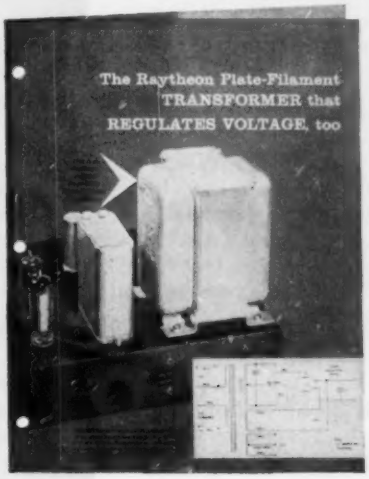
This versatile Raytheon unit looks like a transformer, but does the combined job of transformer plus voltage regulator.

In a conventional power supply circuit, the voltage regulating transformer maintains a dc output voltage within ±3% with line variations of ±15%.

For custom requirements, please write our Applications Engineering Group for an answer to your particular need. Raytheon Company, Manchester, New Hampshire.




**CIRCUIT DIAGRAM** shows Raytheon Voltage Regulating Transformer in typical full-wave rectifier circuit. Three standard models with ratings up to 380 VDC @ 250 MA are immediately available from stock.

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**RAYTHEON COMPANY**
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+FAST SERVICE
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**COMPLETE LINE** includes the new EIA, RS-217 standard sizes.

- Type C: 12,4,2 and 1 mil sizes, in single- and 3-phase, from a fraction of an ounce to 300 pounds.
- Ring Cores: with new polyclad treatment—assure best magnetic performance of any Epoxy resin-coated core ready to receive windings.
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**FAST SERVICE** is assured by complete stocks at Greenville, Pa.; Boston, Mass.; and Los Angeles, Calif.

Performance of Hipersil® cores in "iron-core" components is guaranteed to meet or exceed specifications.

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# WASHINGTON OUTLOOK

WASHINGTON—THE PENTAGON'S SHAKEUP of its space organizations has several results of importance to electronics firms:

The once-powerful Advanced Research Projects Agency is about washed up.

Herbert York, the Pentagon's recently appointed director of defense research and engineering, has a stronger hand in the Pentagon's hierarchy. He now has clearcut policy-making responsibility over all military research and development efforts, including military space projects.

**In the cutting up of ARPA, the Air Force was assigned full control over development of the Midas early-warning and Samos reconnaissance satellites. Later on, it will also get complete responsibility for development, production and launching of all rocket boosters for military space; space transportation projects; and the Discoverer experiments on recovery of space vehicles.**

The Navy was assigned full control over development of the Transit navigation satellite and the Army over the Notus satellite-borne communications system. But both services will have to turn to the Air Force for launching their specially-designed satellites.

The shakeup does not affect the $500-million worth of purely scientific space projects of the National Aeronautics & Space Administration. NASA will remain in charge of scientific earth satellites, lunar probes, deep space probes and other astronautic projects not directly tied to military needs.

**ARPA was set up in the Pentagon during Washington's post-sputnik furor. For the most part, ARPA farmed out operating tasks and contract administration on military space projects to the three services. That's why the new switch in responsibilities will involve no major contract changes.**

The four projects covered by the switchover will total $110.9 million this year. Lockheed is prime contractor on Midas and Samos; Johns Hopkins' Applied Physics Laboratory on Transit; and Philco, GE, Bendix Aviation, ITT, and Radiation, Inc. on Notus. The other projects the Air Force is slated to take over from ARPA have a total budget of close to $200 million.

Defense Secy. McElroy plans to continue ARPA. Its staff of 60 scientists will now be limited to "advanced research" in materials, solid propellants, scientific problems connected with ballistic missile defense, and other non-engineering fields.

- **The success of the Japanese** in selling transistors in the U.S. market is going to be taken up by the Office of Civilian and Defense Mobilization to see whether the booming trade is having a harmful impact on our security.

  **The agency has been asked to investigate the situation by the Electronic Industries Association. The charge is that Japanese production costs are low, that transportation costs are negligible, and that the 15 percent duty helps very little. The result, says EIA, is that a U.S. transistor that sells for $1.35 is up against a competitive Japanese product that sells for 80 cents or less.**

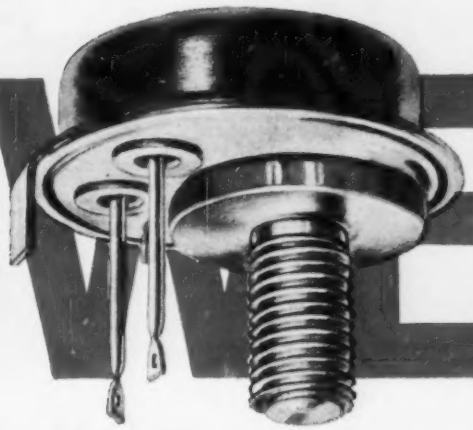
  The EIA's point is this: despite the expansion of U.S. transistor capacity, the Japanese threat is such that U.S. producers won't be able to expand enough or finance enough R&D to keep pace with Soviet and other developments in electronics.

  There's no quick relief available. The OCDM procedures take months and months. First step: allowing interested parties—the U.S. industry, U.S. consumers, manufacturers of finished items, the Defense Department—to say how they think the situation affects them and the security of the country.

# POWER

handling capacity
of the new
Westinghouse
Silicon

# POWER



transistor!

**Greater than 99% efficiency** when used to handle 1.5 kw of power in a low-frequency DC switch! Power loss is only 10-15 watts when handling 1.5 kw. That's just one of the impressive specifications established by a remarkable new semiconductor device—the Westinghouse Silicon Power Transistor.

This Power Transistor is remarkable in other ways, too . . .

- It is the first power transistor available in voltage ranges above 100 volts.
- It has power dissipation capability of 150 watts made possible by the low thermal resistance of .7°C/watt.
- It can operate at higher temperatures than germanium (150°C., compared to 85°C).
- It has astonishingly low saturation resistance—less than .5 ohms at 5 amperes and .75 ohms at 2 amperes, an achievement made possible through extensive research and development of hyper-pure Siemens-Westinghouse Silicon.
- It is 100% power-tested under actual maximum rated specifications before leaving the plant.
- It is encapsulated in a rugged, all-welded case.

**HERE ARE A FEW OF THE APPLICATIONS . . .**

• Inverters and converters • Data processing circuits • Servo output circuits • Series regulated power supplies • As a low frequency switch • In class A amplifiers.

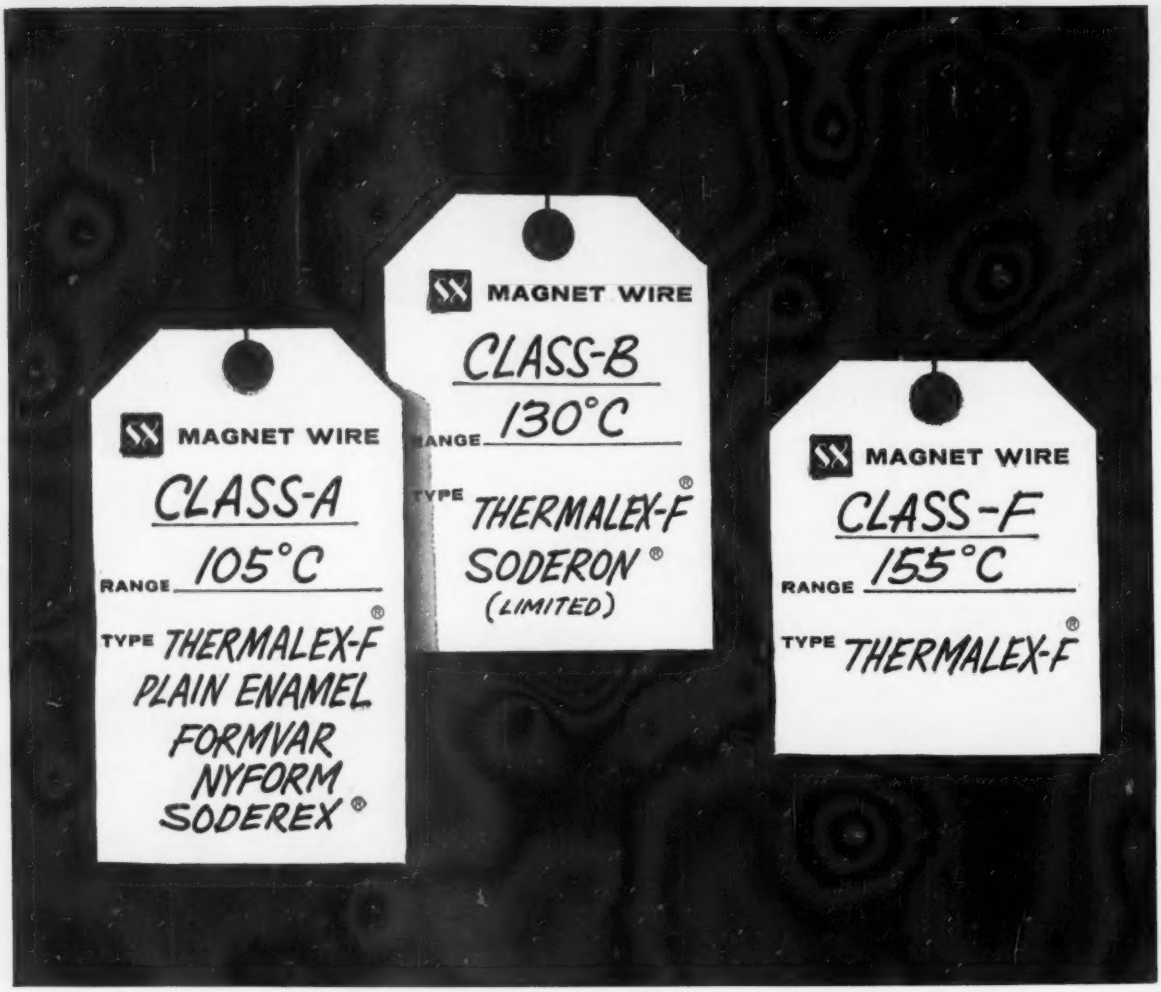
Available in 2 and 5 ampere collector ratings in production quantities now. For complete specifications and details, contact your local Westinghouse representative.

**YOU CAN BE SURE...IF IT'S Westinghouse**

Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Pa.



CIRCLE 15 ON READER SERVICE CARD 

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# ESSEX WIRE CORPORATION

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16 CIRCLE 16 ON READER SERVICE CARD

CIRCLE 17 ON READER SERVICE CARD→

| SERIES | 10B | 20 | 116-216 | 117-217 | 126-226 | 136-236 | 1156C-1256C | H-C |
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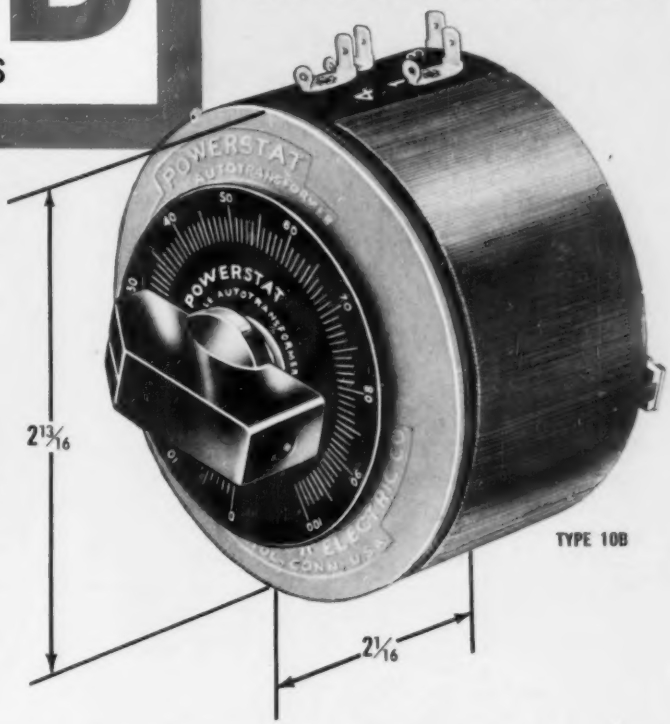
| AMPERES | 1.75 | 3.0 | 7.5<br>3.0 | 10.0<br>4.0 | 12.5<br>6.0 | 20.0<br>9.0 | 45.0<br>28.0 | 200<br>and up |

# the NEW 10B SERIES

## POWERSTAT® variable transformers



TYPE 10B

## 40% INCREASE IN RATING...

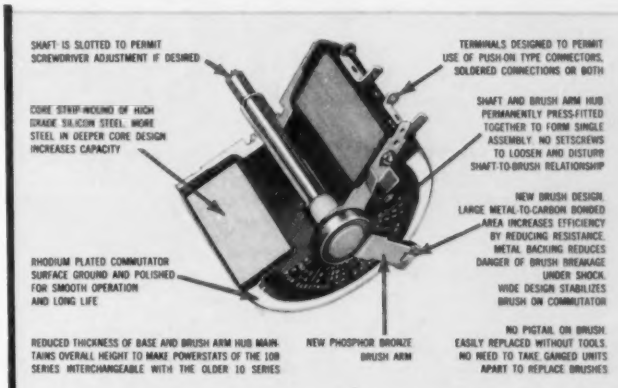
**NO INCREASE IN PRICE!**

**NO INCREASE IN SIZE!**

POWERSTATS of the new 10B Series incorporate the most up-to-date variable transformer design refinements to provide the highest ratings and performance characteristics in their price and size range. Separate ratings are given for constant-impedance and constant-current loads to permit maximum utilization of the POWERSTAT. Features include a rhodium-plated commutator surface and space-saving core and coil design. Ruggedly constructed for long life and dependable service. Two- and three-gang assemblies are available for increased ratings and three-phase operation.

### RATING CHART

| INPUT | | OUTPUT | | | | | |
|---|---|---|---|---|---|---|---|
| VOLTS | CYCLES | VOLTS | CONSTANT CURRENT LOAD MAX. AMPS. | MAX. KVA | CONSTANT IMPEDANCE LOAD MAX. AMPS. | MAX. KVA | TYPE |
| SINGLE | PHASE | | | | | | |
| 120 | 50/60 | 0-120 | 1.75 | .21 | 2.5 | .30 | 10B |
| 120 | 60 | 0-132 | 1.75 | .23 | 1.75 | .23 | |
| 240 | 50/60 | 0-240 | 1.75 | .42 | 2.5 | .60 | 10B-2 |
| 240 | 60 | 0-264 | 1.75 | .46 | 1.75 | .46 | |
| THREE | PHASE | | | | | | |
| 120 | 50/60 | 0-120 | 1.75 | .36 | 2.5 | .52 | 10B-2 |
| 120 | 60 | 0-132 | 1.75 | .40 | 1.75 | .40 | |
| 240 | 60 | 0-240 | 1.75 | .73 | 2.5 | 1.0 | 10B-3 |


SHAFT IS SLOTTED TO PERMIT SCREWDRIVER ADJUSTMENT IF DESIRED
CORE STRIP-WOUND OF HIGH GRADE SILICON STEEL. MORE STEEL IN DEEPER CORE DESIGN INCREASES CAPACITY
RHODIUM PLATED COMMUTATOR SURFACE GROUND AND POLISHED FOR SMOOTH OPERATION AND LONG LIFE
REDUCED THICKNESS OF BASE AND BRUSH ARM HUB MAINTAINS OVERALL HEIGHT TO MAKE POWERSTATS OF THE 10B SERIES INTERCHANGEABLE WITH THE OLDER 10 SERIES
NEW PHOSPHOR BRONZE BRUSH ARM
TERMINALS DESIGNED TO PERMIT USE OF PUSH-ON TYPE CONNECTORS, SOLDERED CONNECTIONS OR BOTH
SHAFT AND BRUSH ARM HUB PERMANENTLY PRESS-FITTED TOGETHER TO FORM SINGLE ASSEMBLY. NO SETSCREWS TO LOOSEN AND DISTURB SHAFT-TO-BRUSH RELATIONSHIP
NEW BRUSH DESIGN. LARGE METAL-TO-CARBON BONDED AREA INCREASES EFFICIENCY BY REDUCING RESISTANCE. METAL BACKING REDUCES DANGER OF BRUSH BREAKAGE UNDER SHOCK. WIDE DESIGN STABILIZES BRUSH ON COMMUTATOR
NO PIGTAIL ON BRUSH. EASILY REPLACED WITHOUT TOOLS. NO NEED TO TAKE GANGED UNITS APART TO REPLACE BRUSHES

**ADAPTER KITS** are available for mounting potentiometers, rheostats, tap switches and other devices to operate in unison with POWERSTAT type 10B. If desired, complete assemblies are furnished with the device already mounted.

THE SUPERIOR ELECTRIC COMPANY
Bristol, Connecticut, U.S.A.

©1950, THE SUPERIOR ELECTRIC COMPANY

| | SERIES | 10B | 20 | 116-216 | 117-217 | 126-226 | 136-236 | 1156C-1256C | H-C |
|---|---|---|---|---|---|---|---|---|---|
| | AMPERES | 1.75 | 3.0 | 7.5<br>3.0 | 10.0<br>4.0 | 12.5/6.0 | 20.0<br>9.0 | 45.0<br>28.0 | 200<br>and up |

# *the* NEW 126-226 SERIES

TYPE 126

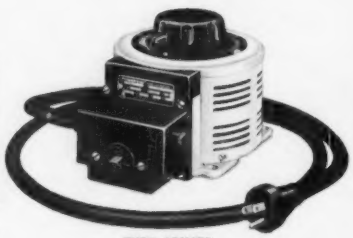
## POWERSTAT® variable transformers

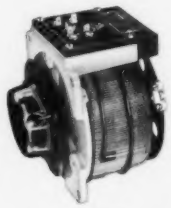
**For control applications having**

**... up to 12.5 amperes constant-current loads**

**... up to 18.0 amperes constant-impedance loads**

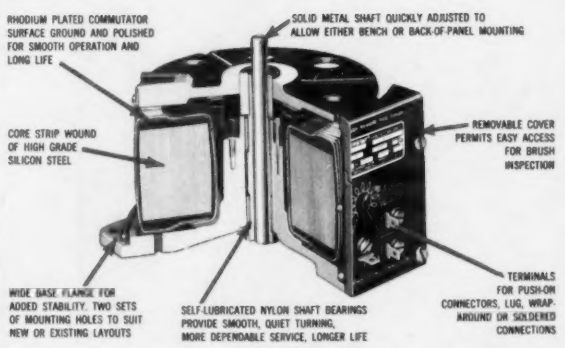
This all-new series rounds out the complete POWERSTAT variable transformer line. The 126-226 series offers open, enclosed, fused, cord-plug and enclosed terminal models; single, two- and three-gang types; manually operated and 5, 15, 30 or 60 second motor-driven assemblies – all available in a new, compact functional design. They incorporate the characteristics inherent in every POWERSTAT: zero wave-form distortion, excellent regulation, high efficiency, conservative ratings, smooth control and linear output voltage.


TYPE 3PN126


TYPE 126U

### RATING CHART

| INPUT VOLTS | INPUT CYCLES | OUTPUT VOLTS | CONSTANT CURRENT LOAD MAX. AMPS. | CONSTANT CURRENT LOAD MAX. KVA | CONSTANT IMPEDANCE LOAD MAX. AMPS. | CONSTANT IMPEDANCE LOAD MAX. KVA | TYPE |
|---|---|---|---|---|---|---|---|
| **SINGLE PHASE** | | | | | | | |
| 120 | 50/60 | 0-120 | 12.5 | 1.5 | 18.0 | 2.2 | 126 |
| 120 | 50/60 | 0-140 | 12.5 | 1.8 | 12.5 | 1.8 | |
| 240 | 50/60 | 0-240 | 6.0 | 1.4 | 9.0 | 2.2 | 226 |
| 240 | 50/60 | 0-280 | 6.0 | 1.7 | 6.0 | 1.7 | |
| 240 | 50/60 | 0-240 | 12.5 | 3.0 | 18.0 | 4.3 | 126-2 |
| 240 | 50/60 | 0-280 | 12.5 | 3.5 | 12.5 | 3.5 | |
| 480 | 50/60 | 0-480 | 6.0 | 2.9 | 9.0 | 4.3 | 226-2 |
| 480 | 50/60 | 0-560 | 6.0 | 3.4 | 6.0 | 3.4 | |
| **THREE PHASE** | | | | | | | |
| 120 | 50/60 | 0-120 | 12.5 | 2.6 | 18.0 | 3.7 | 126-2 |
| 120 | 50/60 | 0-140 | 12.5 | 3.0 | 12.5 | 3.0 | |
| 240 | 50/60 | 0-240 | 6.0 | 2.5 | 9.0 | 3.7 | 226-2 |
| 240 | 50/60 | 0-280 | 6.0 | 2.9 | 6.0 | 2.9 | |
| 240 | 50/60 | 0-240 | 12.5 | 5.2 | 18.0 | 7.5 | 126-3 |
| 240 | 60 | 0-280 | 12.5 | 6.1 | 12.5 | 6.1 | |
| 480 | 50/60 | 0-480 | 6.0 | 5.0 | 9.0 | 7.5 | 226-3 |
| 480 | 60 | 0-560 | 6.0 | 5.8 | 6.0 | 5.8 | |


RHODIUM PLATED COMMUTATOR SURFACE GROUND AND POLISHED FOR SMOOTH OPERATION AND LONG LIFE
SOLID METAL SHAFT QUICKLY ADJUSTED TO ALLOW EITHER BENCH OR BACK-OF-PANEL MOUNTING
CORE STRIP WOUND OF HIGH GRADE SILICON STEEL
REMOVABLE COVER PERMITS EASY ACCESS FOR BRUSH INSPECTION
WIDE BASE FLANGE FOR ADDED STABILITY. TWO SETS OF MOUNTING HOLES TO SUIT NEW OR EXISTING LAYOUTS
SELF-LUBRICATED NYLON SHAFT BEARINGS PROVIDE SMOOTH, QUIET TURNING, MORE DEPENDABLE SERVICE, LONGER LIFE
TERMINALS FOR PUSH-ON CONNECTORS, LUG, WRAP-AROUND OR SOLDERED CONNECTIONS

**THE SUPERIOR ELECTRIC COMPANY, Bristol, Connecticut**

Please send:

☐ POWERSTAT Bulletin on 10B Series.

☐ POWERSTAT Bulletin on 126-226 Series.

☐ Please have your representative call.

name _____

company _____

address _____

city _____ zone _____ state _____

T S E C O S O F I A Z L A G F

**... FOR YOUR FILES**

Request 10B Series Bulletin and 126-226 Series Bulletin giving full technical information, ratings and specifications.

**THE SUPERIOR ELECTRIC COMPANY**

**Bristol, Connecticut, U.S.A.**

SE-L83910

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The career-climb is easier... and there's more room at the top... at Link Aviation's Research & Development Laboratory at Palo Alto. The professional atmosphere here is built on policies which give engineering talent room to expand – reward it when it does.

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Link now has staff openings for ambitious engineers with experience in: analog or digital computer components and systems; missile systems analysis; radar simulation; industrial and process control and engineering psychology.

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General Precision Equipment Corporation

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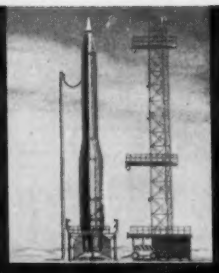


VA-210B

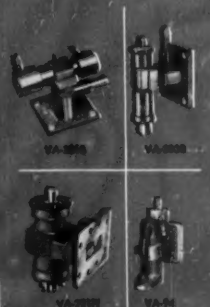
FOR RADAR
RECEIVERS

# VARIAN KLYSTRONS

## HIGH FREQUENCY STABILITY, RUGGED CONSTRUCTION, LONG LIFE

The new VA-210B Klystron is a super-rugged oscillator, engineered to give long, reliable service under severe operating conditions. Frequency is extremely stable, even under conditions of the most severe shock, vibration and temperature variation. Features include a unique brazed-on external tuning cavity, a very rugged, quick-heating cathode, a slow-rate non-microphonic tuner and an all metal and ceramic construction.

Varian makes a wide variety of Klystrons and Wave Tubes for use in Radar, Communications, Tests and Instrumentation, and for Severe Environmental Service Applications. Over 100 are described and pictured in our new catalog. Write for your copy.



VARIAN associates
TUBE DIVISION
PALO ALTO 1, CALIFORNIA
Representatives throughout the world

| | | |
|---|---|---|
| VA-210B | 8.4 to 10.8 kMc | 30 mW |
| VA-291B | 8.2 to 9.6 kMc | 90 mW |
| VA-292B | 8.5 to 9.6 kMc | 30 mW |
| VA-94 | 16.8 to 17.0 kMc | 40 mW |
| VA-221H | 3.28 to 4.56 kMc | 40 mW |

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, N. M. R. SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

# Two Stock Splits Announced

TWO-FOR-ONE STOCK SPLIT has been voted by stockholders of **Continental Connector Corp.**, Woodside, N. Y. The firm's board of directors also declared a quarterly dividend of 12½ cents on the new split class A shares. This dividend on the basis of the old non-split stock would have amounted to 25 cents a share, as compared with the 15 cents a share previously paid.

• **Litton Industries** stockholders have received announcement of a two-for-one split voted in mid-September by company directors. Stockholders will vote at the regular annual meeting slated for Nov. 21 on the increase of authorized shares for this purpose.

• **Collins Radio,** Cedar Rapids, Ia., board of directors have declared a regular quarterly dividend of 50 cents a share on the firm's 4-percent cumulative preferred stock.

• **Airwork Corp.,** Millville, N. J., has declared a stock dividend of three percent on common shares, payable Oct. 15 to stockholders of record at the close of business Sept. 30. Cash will be paid in lieu of fractional shares. This is the first dividend to be paid by Airwork, which made its first public offering in July of this year. The company was organized in 1946 and is engaged in repair and overhaul of aviation electronics gear, instruments and aircraft engines.

• **Northern Plastics Co.,** La-Crosse, Wis., has declared a special year-end stock dividend of 10 percent in addition to its usual dividend of 10 cents a share. The company manufactures industrial laminates and other plastic products for the electronic and electrical industries.

• **Leetronics, Inc.,** Brooklyn, N. Y., stockholders have received dividend checks of 7 cents a share. Payment was made to stockholders of record at the close of business Sept. 17.

• **A quarterly dividend** of 12½ cents a share on 5 percent preferred stock was paid on the first of this month to shareholders of **Fischer and Porter Co.,** Hatboro, Pa. The company makes data reduction systems as well as industrial instruments and precision glass products.

• **Motorola** announces stock dividend of 37½ cents a share payable to stockholders of record on Sept. 30. Checks will start on their way on Oct. 15.

• **General Electric** stockholders of record on Sept. 25 will receive dividend checks in the amount of 50 cents a share on Oct. 28. This will represent GE's regular quarterly dividend.

• **Central Transformer,** Chicago, has issued dividend checks of 15 cents a share to stockholders of record on the first day of last month.

## 25 MOST ACTIVE STOCKS

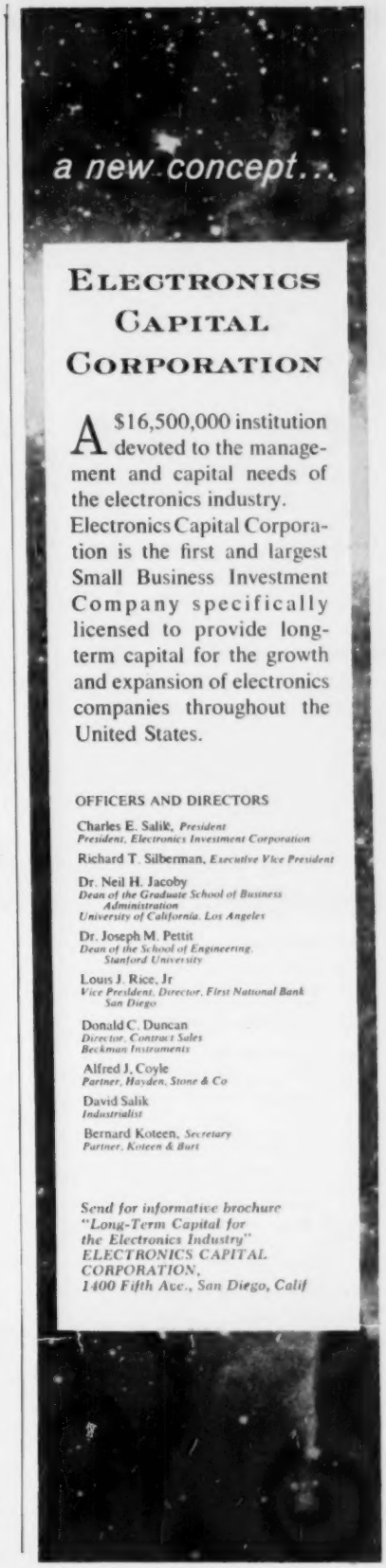
WEEK ENDING SEPTEMBER 25

| | SHARES (IN 100's) | HIGH | LOW | CLOSE |
|---|---|---|---|---|
| Avco | 1362 | 13¼ | 11½ | 12⅞ |
| Int'l Tel & Tel | 1138 | 34½ | 30⅛ | 33¾ |
| Sperry Rand | 1020 | 23⅛ | 22½ | 22¾ |
| Zenith | 886 | 98⅞ | 87¼ | 95¼ |
| Gen Tel & Elec | 766 | 69⅜ | 66 | 69 |
| Gen Elec | 717 | 77¾ | 74 | 77½ |
| RCA | 650 | 58⅞ | 54¾ | 58⅛ |
| Lear Inc | 603 | 14⅛ | 11 | 13½ |
| Raytheon | 582 | 47⅞ | 44⅝ | 46⅝ |
| Texas Inst | 537 | 131½ | 117¼ | 131 |
| Gen Dynamics | 530 | 46¾ | 44 | 46¼ |
| Univ Control | 506 | 17¼ | 15¾ | 16⅞ |
| Westinghouse | 462 | 91⅝ | 86¾ | 91 |
| Burroughs | 395 | 30⅝ | 29⅛ | 30½ |
| Emerson | 375 | 15½ | 12⅜ | 14¾ |
| Elec & Mus Ind | 359 | 7¼ | 6⅞ | 7 |
| Admiral | 354 | 20⅞ | 17 | 20¼ |
| Philco | 335 | 25⅜ | 21¼ | 24¾ |
| Litton Ind | 338 | 110⅞ | 102⅛ | 110⅜ |
| Amer Bosch Arma | 336 | 28⅜ | 23¾ | 27¾ |
| Standard Coil | 335 | 16 | 13¾ | 15¾ |
| Dynamics Corp | 308 | 8¾ | 7¼ | 8⅛ |
| Beckman Inst | 305 | 52¼ | 47 | 51¼ |
| Ampex Corp | 297 | 78½ | 72¼ | 78½ |
| Int'l Bus Mach | 292 | 422 | 401 | 419½ |

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co. investment bankers.

## STOCK PRICE AVERAGES

| (Standard & Poor's) | Sept. 23, 1959 | Aug. 26, 1959 | Change From One Year Ago |
|---|---|---|---|
| Electronics mfrs. | 82.40 | 89.05 | +37.1% |
| Radio & tv mfrs. | 99.55 | 108.67 | +67.3% |
| Broadcasters | 90.42 | 97.41 | +30.8% |



a new concept...
ELECTRONICS CAPITAL CORPORATION
A $16,500,000 institution devoted to the management and capital needs of the electronics industry.
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# NEW TRANSISTORIZED PORTABLE OSCILLOSCOPE

*Operates from* { Internal Battery, External DC and AC Line

## TYPE 321

**TRULY PORTABLE**

Battery Powered.
Weighs only 13½ lbs. without batteries.
Batteries weigh 2 to 4 lbs.
Size only 5¾" x 8¼" x 16".

**HIGH PERFORMANCE**

Vertical Response: DC to 5 MC, 0.07 μsec risetime.
Calibrated Sensitivity: 0.01 v/div to 20 v/div in 11 calibrated steps. Continuously adjustable from 0.01 v/div to 50 v/div.
Calibrated Sweeps: 0.5 μsec/div to 0.5 sec/div in 19 calibrated steps. Accurate 5x magnifier extends calibrated range to 0.1 μsec/div. Continuously adjustable from 0.1 μsec/div to 1 sec/div.
Simplified Triggering: Fully automatic, or amplitude-level selection with preset stability control.
4-KV Accelerating Potential on 3" crt.
6-div by 10-div Display Area.
Amplitude Calibrator.

**NO POWER SOURCE PROBLEMS**

Operates from:

1. Ten size D Flashlight cells, ⅓ hour continuous, more with intermittent, operation.
2. Ten rechargeable cells, 2.5AH—3 hours continuous operation. Ten rechargeable cells, 4.3AH—5 hours continuous operation.
3. 11 to 35 v dc (aircraft, auto, boat, etc.).
4. 105 to 125 v ac or 210 to 250 v ac, 50 to 800 cps.

| | |
|---|---|
| **Price** | **$775.00** |
| **Built-in Battery Charger** | **35.00** |
| **Complete Set of 2.5AH Batteries** | **36.50** |
| | f.o.b. factory |

It's so easy to take the Type 321 wherever an oscilloscope is useful. It's a convenient solution to many difficult situations, too . . . for example: Where power cords are apt to be a nuisance—where isolation from ground is desirable—where power-line fluctuations are troublesome—where hum pick-up is a problem. The Type 321 is sure to satisfy your portable oscilloscope needs.

## *Tektronix, Inc.*

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**ENGINEERS**—Interested in furthering the advancement of the oscilloscope? We have openings for men with creative ability in circuit and instrument design, cathode-ray tube design, and semiconductor research. Please write Richard Rapiequet, V.P., Eng.

***If you missed the Type 321 at WESCON, see it at NEC, booth 193-194.***

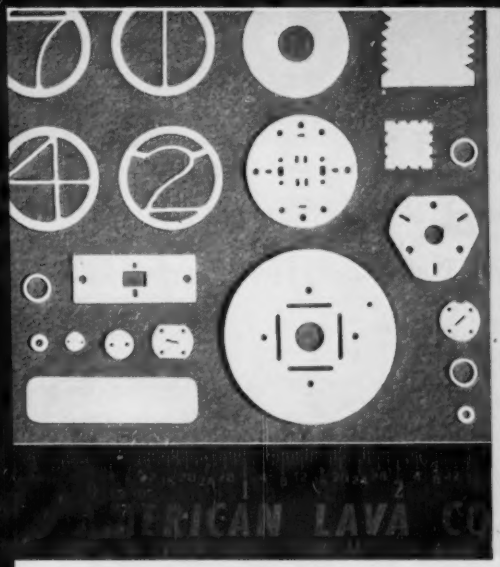


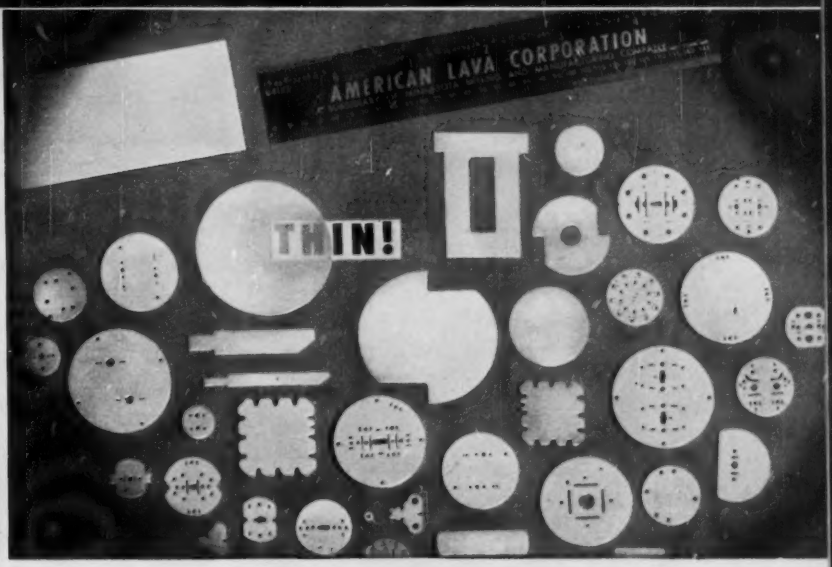
CIRCLE 23 ON READER SERVICE CARD→

# NEW AlSiMag® THIN CERAMICS!

***will these alumina ceramics give you***

## SMALLER, LIGHTER, MORE RUGGED UNITS?






Miniature AlSiMag Alumina Ceramics—some as thin as 0.005"—are being used in electron tubes, microwave windows, transistor platforms . . . as insulators in hearings aids . . . in digital counter tubes, radio crystal cages . . . in high temperature transformers, relays, fuses, micro-modules . . . high temperature amplifiers . . . and other high temperature devices including high temperature printed circuitry . . . as well as various mechanical applications.

The relatively high strength of these thin ceramics and their superior performance in high temperature, high frequency applications may help you answer the demands for smaller, lighter, more rugged units. This strength also sharply reduces damage from fatigue failure, heat deterioration, shock and vibration, and makes new automatic assembly operations practical.

Since these thin ceramics were pioneered by American Lava several years ago, demand has increased rapidly and steadily. Spurred by constantly increasing requirements, our production facilities are now capable of shipping in volume and at practical prices, small intricate shapes that were considered impossible as recently as 1955.

***Free bulletin and typical samples of thin AlSiMag Ceramics sent on request***

A Subsidiary of Minnesota Mining and Manufacturing Company

**AMERICAN LAVA CORPORATION**

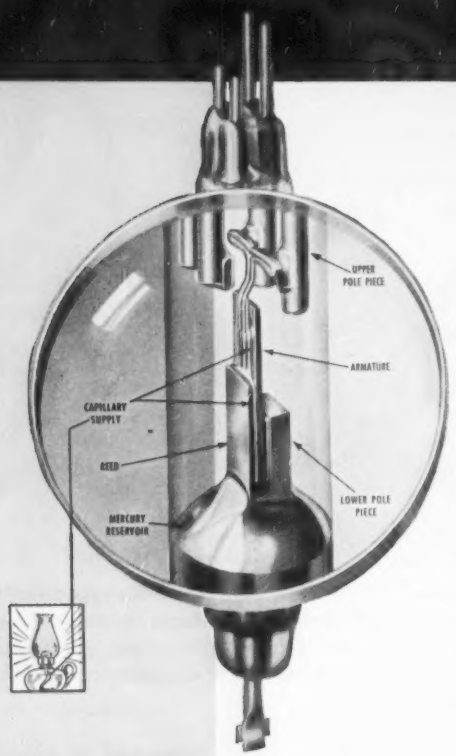
**CHATTANOOGA 5, TENN.**
58TH YEAR OF CERAMIC LEADERSHIP

**For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory):** Atlanta, Ga. • Boston: Newton Center, Mass. • Buffalo, N. Y. • Chicago: Bedford Park, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas • Detroit, Mich. • High Point, N. C. • Los Angeles, Cal. • New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash. **Canada:** Minnesota Mining & Manufacturing of Canada, Ltd., P. O. Box 757, London, Ontario. **All other export:** Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

# Over 8 billion* operations

# CLARE Mercury-Wetted

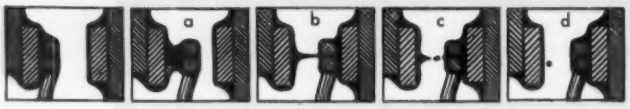
*with contact load of 250 volt-amperes.



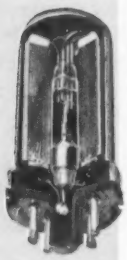

## NEVER WEAR OUT

Longevity is built into these relays. The basic magnetic switch is sealed in a glass capsule filled with pressurized hydrogen. With every make and break the mercury-film contact surface is renewed . . . by capillary action, like a lamp wick. These contacts never get dirty, never lock or weld and *NEVER WEAR OUT.*

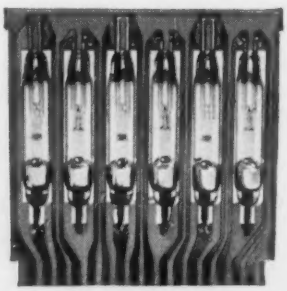
## NEVER CHATTER OR BOUNCE




Contact closure between the two liquid surfaces bridges any mechanical chatter and prevents its appearing in the electrical output. (a) Filament of mercury forms between the contacts as they separate. (b) This becomes narrower in cross section and (c) finally parts at two points, allowing a globule of mercury to fall out. (d) The extremely fast break minimizes the arc and adds greatly to contact load capacity.



## NO MAINTENANCE REQUIRED



HG Relay cutaway to show magnetic switch surrounded by operating coil and encased in a metal housing.

HGS Relay cutaway to show biasing magnets attached to the ends of the side plates.

HG6F Relay printed circuit panel showing six in-line mercury-wetted contact switches mounted in minimum space.

**With all working parts sealed and switches and coils enclosed in metal housings, these relays are tamper-proof and always in constant adjustment. They require no maintenance whatsoever.**

# –with no maintenance!

# Contact Relays on test 4 years

## A FULL LINE OF THE MOST RELIABLE, MOST DURABLE RELAYS EVER MADE

*single form D*

**Type HG.** Capable of up to 100 operations a second. Load-handling capacity to 5 amperes and up to 500 volts. (250 va max. with proper contact protection.)

*single form D*

**Type HGP.** Can be factory adjusted to provide single side-stable, bi-stable or chopper characteristics.

*single form D*

**Type HG5.** Biased with permanent magnets. Speed up to 200 cps. Sensitivity as low as ±2.5 milliwatts. Handles up to 2 amperes, up to 500 volts (100 va max. with proper contact protection.)

*four form D*

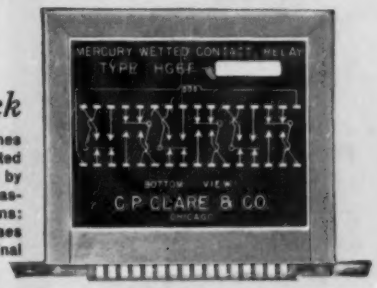
**Type HG4.** Four form D switches enclosed in a single housing with coil. Plug-in assembly (shown) is standard. Other mountings available.

*two or three form D*

**Types HG2 and HG3.** Two or three form D Switches enclosed in a single housing. HG2 has 8 or 11-pin octal style plug. An 11-pin base is standard for HG3.

*six in-line flat pack*

**Type HG6F.** Six switches mounted in line on printed circuit panel surrounded by single coil. Flat, compact assembly. Over-all dimensions: 3.640" x 3.125" x 1.046". Uses standard 32 or 36 terminal printed circuit socket.




For complete information on CLARE Mercury-Wetted Contact Relays or on the entire CLARE line of superior relays and electronic components address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Limited, P. O. Box 73, 2700 Jane Street, Downsview, Ontario. Cable Address: CLARELAY.

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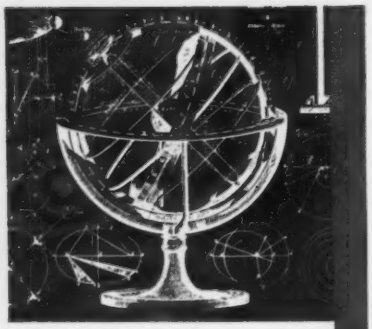

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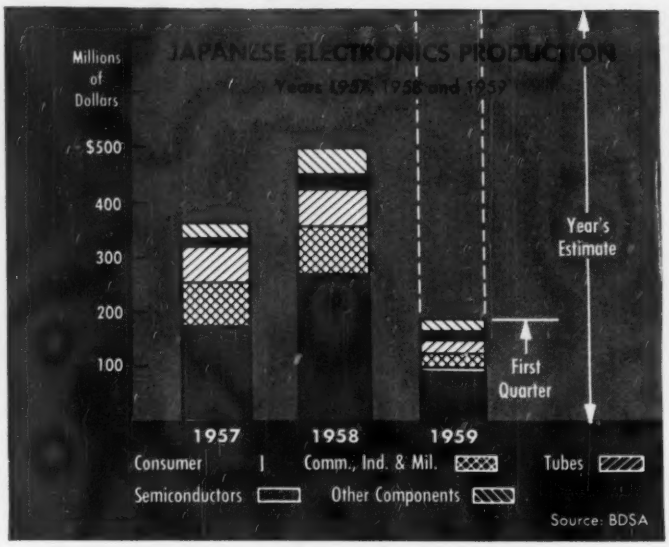



# Japan's Production Jumps 48%

JAPANESE PRODUCTION of electronic gear in 1959 is running 48 percent ahead of 1958, Business and Defense Services Administration reports. Last year Japan was the world's fourth largest producer of electronic products, ranking behind the United States, United Kingdom and West Germany.

Japan's first-quarter production this year was worth $184.4 million at factory values, which is equivalent to an annual rate of $736 million. This projected 1959 production is $238 million in excess of 1958 production of $498 million and twice 1957 production of $362.2 million. Actual figures were supplied to BDSA by U. S. Embassy in Tokyo.

U. S. electronic production is running at an annual rate of approximately $8.5 billion, BDSA claims. However, other industry estimates for 1959 are over $9 billion.

Consumer electronics contributed the greatest increase in Japanese end-equipment production between 1957 and 1958, rising from $170.9 million to $266.2 million. Television receivers were the key consumer item, with production rising from 0.6 million units worth $86.8 million in 1957 to 1.2 million sets worth $154.1 million in 1958. Radio set production grew from 3.6 million units worth $67.0 million to 4.9 million units worth $87.1 million over the two-year period.

Production of military, commercial and industrial items totaled only $85.2 million in 1958 and $26.8 million in the 1959 first quarter (equivalent to an annual rate of $107.2 million). However, items produced covered a broad product spectrum, including radio and tv broadcasting, industrial tv, r-f and microwave communications, detection and navigation, ultrasonics, high-frequency heating and other equipment.

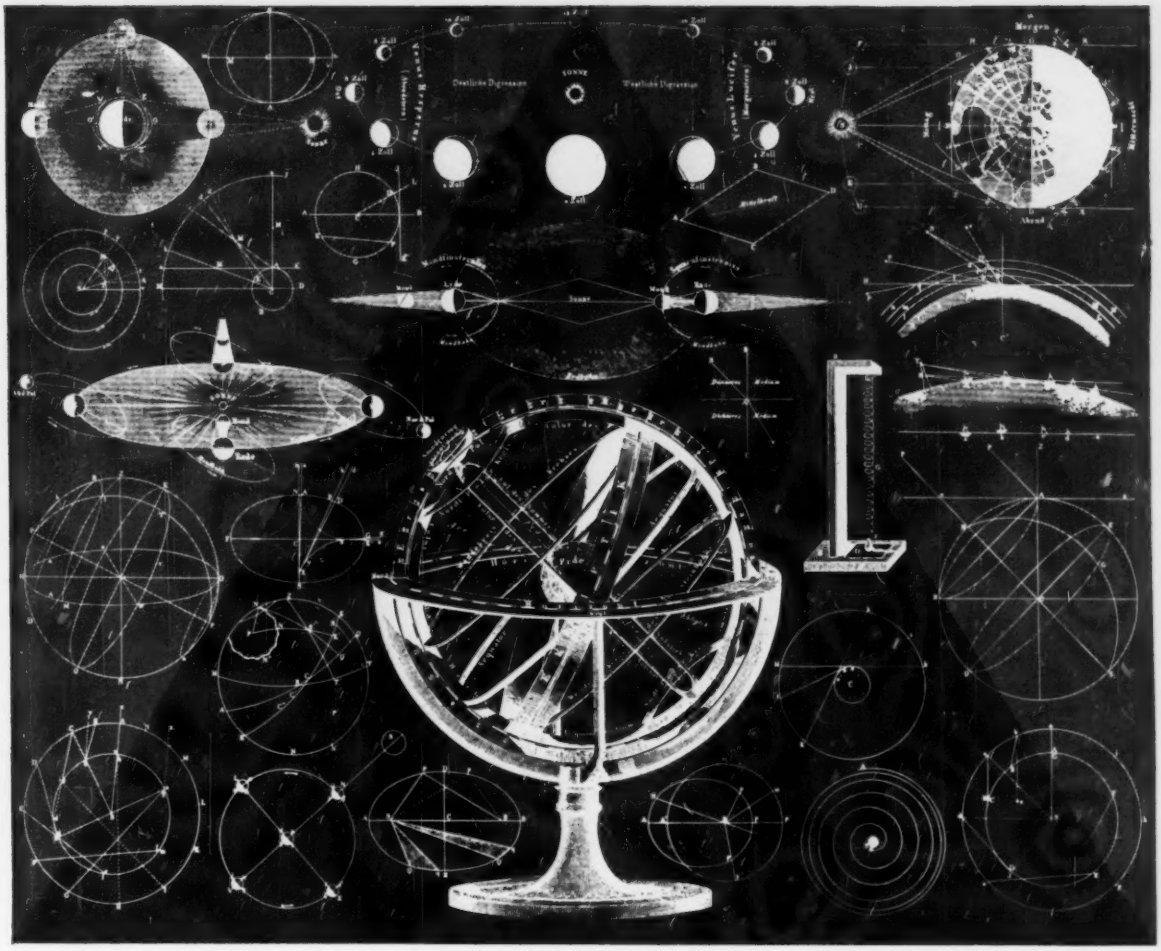
Semiconductors registered a 129-percent increase in production value between 1957 and 1958, jumping from $10.7 million to $24.5 million. First quarter 1959 production amounted to $11.5 million.

Transistors were the principal semiconductor item. In 1957, 5.7 million units valued at $8.9 million were produced, which compares with 26.7 million units valued at $21.4 million in 1958 and 15.0 million valued at $9.9 million in the first quarter of 1959.

## FIGURES OF THE WEEK

### LATEST WEEKLY PRODUCTION FIGURES

| (Source: EIA) | Sept. 18, 1959 | Aug. 21, 1959 | Change From One Year Ago |
|---|---|---|---|
| Television sets | 166,118 | 138,758 | 39.8% |
| Radio sets, total | 421,143 | 274,526 | 35.9% |
| Auto sets | 155,338 | 83,041 | 41.3% |



# *Guided tour of the solar system*

The new NASA Thor-boosted research rocket, DELTA, now being constructed by Douglas, will set up big signposts for further space explorations. Combining elements already proved in space projects with an advanced radio-inertial guidance system developed by the Bell Telephone Laboratories of Western Electric Company, DELTA will have the versatility and accuracy for a wide variety of satellite, lunar and solar missions. Douglas insistence on reliability will be riding with these 90 foot, three-stage rockets on every shoot. At Douglas we are seeking qualified engineers to join us on this and other equally stimulating projects. Some of our requirements are listed in our column on the facing page.

**Maxwell Hunter, Asst. Chief Engineer—Space Systems, goes over a proposed lunar trajectory with Arthur E. Raymond, Senior Engineering Vice President of DOUGLAS**

MISSILE SYSTEMS ■ SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT

# class of '52
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Electron Devices Meeting, Washington, Oct. 29-31

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**DEarborn 2-0776**

**BALTIMORE: OCT. 26-28**
**phone Mr. C. T. Petrie**
**LExington 9-8442**

**WASHINGTON: OCT. 29-31**
**phone Mr. C. T. Petrie**
**ADams 4-0700**

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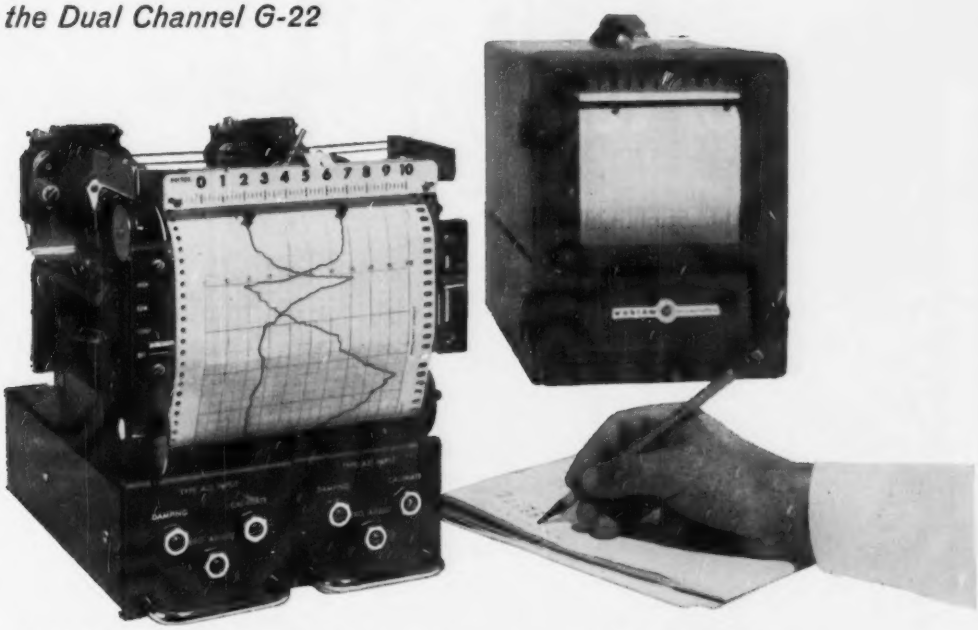
*Announcing the newest*

## VARIAN Potentiometer RECORDER

*the Dual Channel G-22*



MOST COMPACT AND PORTABLE

# TWO-CHANNEL RECORDER

Size and price need no longer limit the use of two-channel recorders. The Varian G-22 is the least expensive servo-operated two channel available — and also the most compact. It puts two time-correlated variables onto one chart of 5-inch calibrated width.

The Varian G-22 is of completely modular design — and a truly versatile instrument. Plug-in input chassis are interchangeable to provide various recording characteristics. Chart motors are easily changed for additional speeds. Range is adjustable from 0-9 mv to 0-100 mv on the basic input chassis. Zero can be set anywhere across the chart. And being a potentiometer recorder, the G-22 has the necessary sensitivity to serve a wide variety of recording needs.

**FEATURES**

- Potentiometer measuring circuit thousands of times more sensitive than a galvanometer.
- Quickly interchangeable plug-in input chassis provide various recording characteristics.
- Two-speed gear shifter standard; four chart speeds available by dual motor option. Choice of speeds from ⅛ in/hr to 8 in/min.
- Modular construction throughout; permits rapid removal of subunits with a screwdriver.
- Panel mount or portable versions available. Total weight is 35 pounds.
- 1 % limit of error and one second full-scale balancing time.
- Cast aluminum case and box frame structure provide ruggedness.
- Direct shaft connection between servo motor and potentiometer provides positive drive and allows space for optional accessories.
- Accessories include retransmitting slidewires, event markers, and alarm contacts.
- Capillary pens and large reservoirs provide reliable inking.
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*For full information, write the Instrument Division*

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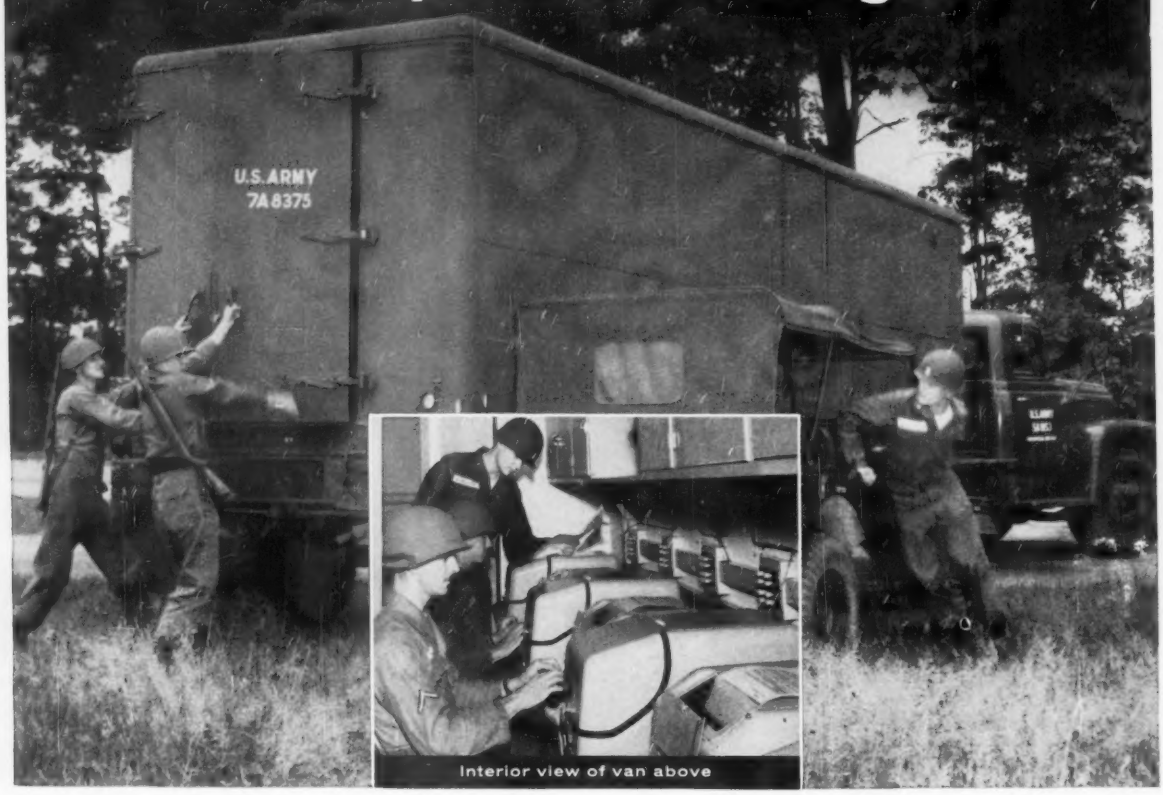
# NERVE CENTER
## *for teleprinted messages*




Interior view of van above

### *Kleinschmidt teletypewriters move up with the U. S. Army, operating without interruption under combat conditions*

Constant contact, *in print,* between combat headquarters and widely-dispersed field units! Developed in cooperation with the U. S. Army Signal Corps, Kleinschmidt teletypewriters in this mobile communications center are capable of sending and receiving thousands of teleprinted messages a day. Operation is fast, accurate, dependable, simple. In recognition of proved performance, Kleinschmidt equipment for the U. S. Army is manufactured under the Reduced Inspection Quality Assurance Plan. Now Kleinschmidt experience points toward new accomplishments in electronic communications for business and industry. The new concepts, new applications are virtually unlimited.

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***DIVISION OF SMITH-CORONA MARCHANT INC., DEERFIELD, ILLINOIS***

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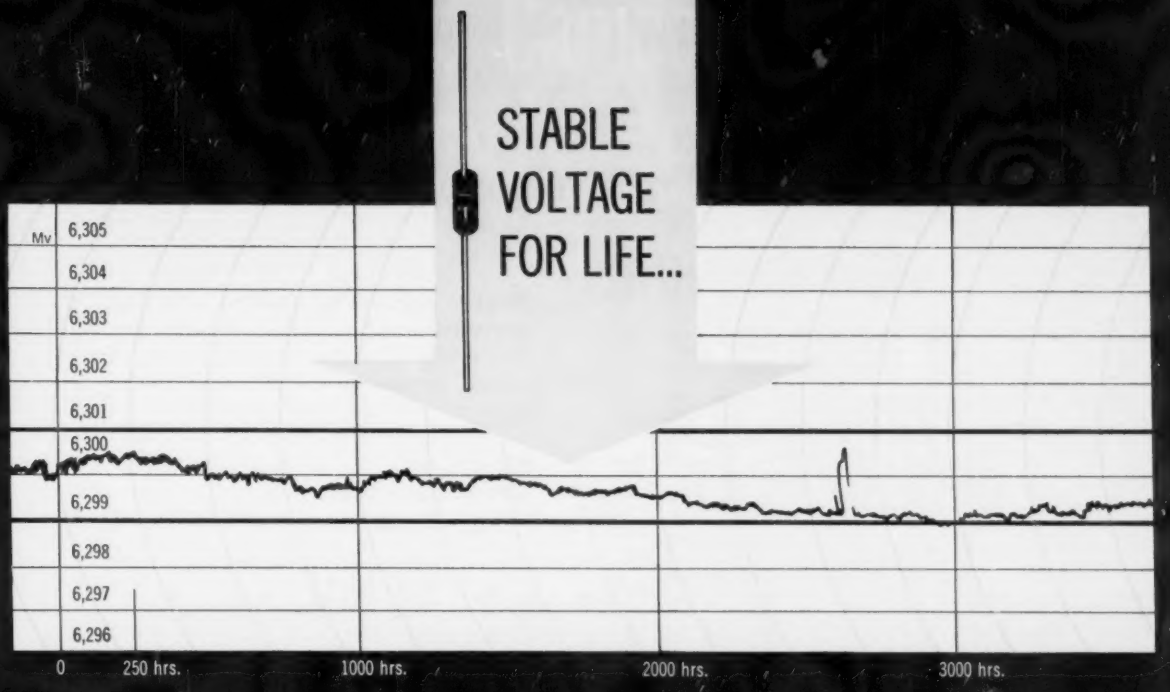


# NEW ULTRA-STABLE ZENER DIODES

| Type | Voltage Range at $I_Z$ = 7.5 ma at 25°C (Volts) Min. | Max. | Temp. Coefficient[2] (−55°C to +100°C) at $I_Z$ = 7.5 ma (%/°C) | Maximum Dynamic[3] Resistance at 25°C at $I_Z$ = 7.5 ma (ohms) | Operating and Storage Temperature Range (°C) | Max. Operating Temp. at $I_Z$ = 7.5 ma (°C) |
|---|---|---|---|---|---|---|
| 1N821 | 5.9 | 6.5 | ±.01 | 15 | −65 to +150 | +125 |
| 1N822[1] | ±5.9 | ±6.5 | ±.01 | 15 | −65 to +150 | +125 |
| 1N823 | 5.9 | 6.5 | ±.005 | 15 | −65 to +150 | +125 |
| 1N824[1] | ±5.9 | ±6.5 | ±.005 | 15 | −65 to +150 | +125 |
| 1N825 | 5.9 | 6.5 | ±.002 | 15 | −65 to +150 | +125 |
| 1N827 | 5.9 | 6.5 | ±.001 | 15 | −65 to +150 | +125 |

[1]Double anode types.
[2]Determined by measuring a change of voltage from −55°C to +25°C and a change of voltage from +25°C to +100°C.
[3]The Dynamic Resistance is measured by superimposing a small A.C. Signal upon the test D.C. Current. ($I_{AC}$ RMS ≤ 1/10 $I_{DC}$ Test)

1N822 and 1N824 types meet all specifications, including temperature coefficient, in both directions.

This new line of subminiature silicon voltage references features a combined lower dynamic resistance and voltage stability exceeding that of *any* standard cell.

Manufactured by diffusion, these devices offer temperature coefficients as low as 0.001% °C. Unique single piece construction enables the reference to maintain excellent voltage stability when subjected to severe thermal shocks. Axial lead design and hermetically sealed glass encapsulation insure a rugged unit capable of providing long term reliability over wide ranges of environmental conditions.

These new subminiature references are also available in double anode types for symmetrical clipping applications.

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| 250 MW | SV5 – SV24 |
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Use of the following form will, we hope, reduce to a minimum the inconvenience of submitting an employment inquiry, yet will still permit us to give you a reasonably definitive reply.

*Please airmail to:*
Mr. Robert A. Martin, Supervisor, Scientific Employment
**Hughes Research and Development Laboratories**
Culver City 66, California

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*Name*_____

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***I am interested in one of the following types of assignment:***

- ☐ RESEARCH
- ☐ DEVELOPMENT
- ☐ PRODUCT ENGINEERING
- ☐ TECH. ADMIN.
- ☐ SYSTEMS
- ☐ FIELD TEST
- ☐ OTHER:_____
- ☐ _____

***I have had professional experience in the following specific areas:***

- ☐ CIRCUIT ANALYSIS AND DESIGN
- ☐ DIGITAL COMPUTERS
- ☐ GUIDANCE DEVICES
- ☐ MICROWAVES
- ☐ STRESS ANALYSIS
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- ☐ MATERIALS
- ☐ SYSTEMS ANALYSIS
- ☐ R-F CIRCUITS
- ☐ RELIABILITY
- ☐ ATOMIC AND/OR SOLID STATE PHYSICS
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- ☐ ELECTRO-MECHANICAL DESIGN
- ☐ OTHER:_____
- ☐ _____
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***I have had a total of _____ years of experience.***



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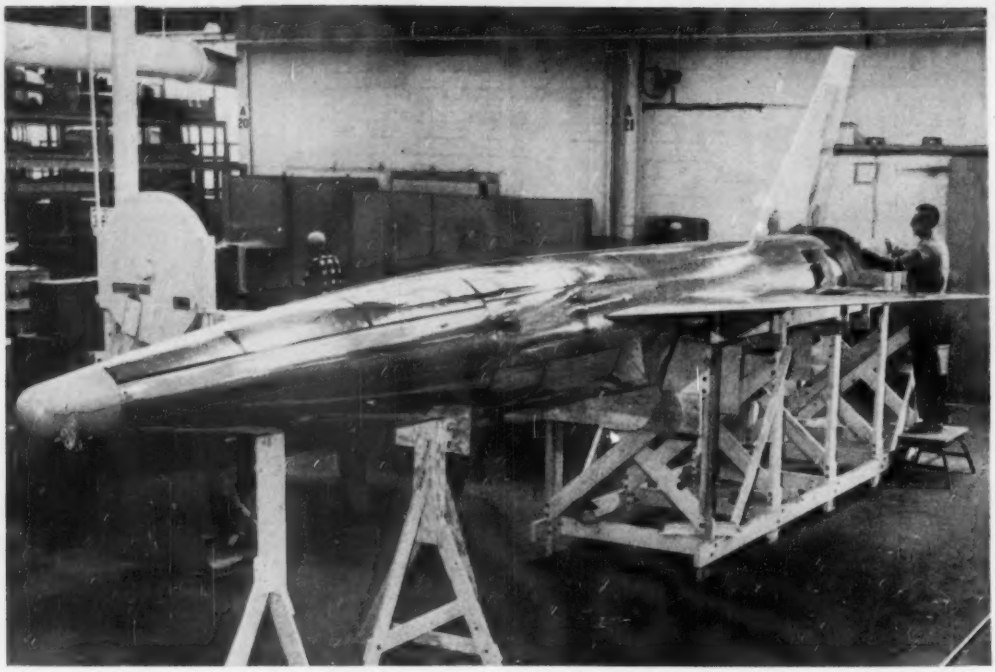

Army's SD-4 "Swallow" reconnaissance drone (mockup shown here) will use infrared, radar, photography and other sensory devices over enemy battlefield. Prime contractor Republic holds $30 million in contracts for the system

# From Airframes to Electronics

**Aircraft firms are pushing electronics expansion. It's the key to full weapon systems capability—and new opportunities for profits**

"To OBTAIN complete weapon systems responsibility today you've got to show capability in electronics. You can't be in the running for the big contracts if you depend on a subcontractor to tell you how to integrate his black box into your system."

This comment, from an official of an airframe company now pushing electronics expansion, typifies the attitude of most of the aircraft industry.

### *Setting Up Rapidly*

A substantial number of plane builders, of course, have been a part of electronics for years and owe much to early electronics planning. Now, other airframe makers are rapidly setting up their own electronics research and engineering groups.

Continuing trend towards more electronics in the aircraft industry is largely the result of demand by the armed services that a weapon systems manager have complete systems capability, including electronics knowhow.

Apart from satisfying a military requirement for weapon systems management, electronics work in the aircraft industry is being spurred by new opportunities for profits. Electronics is taking more and more of the contract dollar.

Rather than buy from subcontractors, many aircraft firms are building their own electronic components. Another reason for in-house production of electronic subsystems and components is a need for extremely specialized gear, often in limited quantity.

### *Acquiring Knowhow*

Since there has been a stepped-up rate of research in recent years by industrial and government laboratories that affects technical and business trends in electronics, aircraft firms also have found it necessary to embark on research programs to keep in the forefront of technology.

Research and engineering teams in various electronics fields permit planemakers to build up a variety of useful knowledge. These teams are also pools of skilled manpower for testing and evaluating available hardware and components, especially useful when management must decide whether to buy an item or make its own.

Device development can follow naturally from these cores of scientific organization if management decides the facts call for this.

The commercial aircraft market is by no means being overlooked in the planemakers' electronics expansion. Advent of jet airliners has accented the same systems management problems and opportunities that have arisen in the military field.

Evolution of aircraft design has also influenced the planemaker's role in electronics. For some time

antenna systems have been designed and manufactured by airframe makers because antenna configuration is so much a part of the configuration of the plane itself.

Supersonic jet craft have tied in electronics more closely with aerodynamics. Now, electronic controls are usually necessary to make aircraft flight stable.

How far will the aircraft firms go in electronics?

Off-the-record conversations with aircraft company officials suggest that the future will see electronic gear being marketed more and more by companies that once made only airframes. At first, such gear is likely to consist of critical aircraft subsystems and components.

Some aircraft firms that jumped into electronics to beef up their systems engineering have seen this effort return profit in other ways. Their electronics divisions now market subsystems and components to outside airframe companies, submarine builders and other firms outside the aircraft industry.

## Satellites Point Cameras at Moon

WASHINGTON — The photograph of the earth made recently from a satellite at an altitude of 17,000 mi is the forerunner of a series of satellite photographs planned by the National Aeronautics and Space Administration.

Before the end of the year, NASA hopes to make similar photographs of the dark side of the moon and extensive pictures of the earth's cloud coverage. Eventually, spokesmen working on the project say, earth pictures of Venus and other planets will be made.

The picture was made from the Explorer VI satellite launched on Aug. 7. Equipment included a 2-lb camera and three transmitters—a digital transmitter operating on a 378-mc frequency and two analog transmitters operating on 108.06 mc and 108.09 mc.

Equipment to photograph the moon, however, will use only digital transmitters because of better speed and accuracy. It will employ 150-watt transmission—same as for the Explorer VI pictures.

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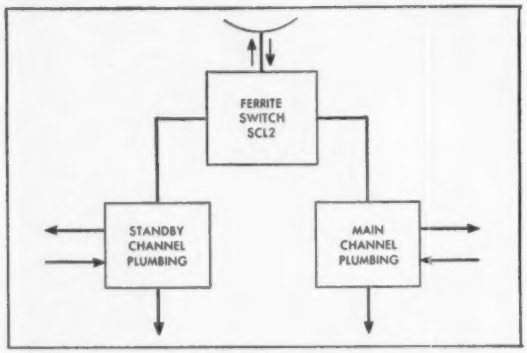
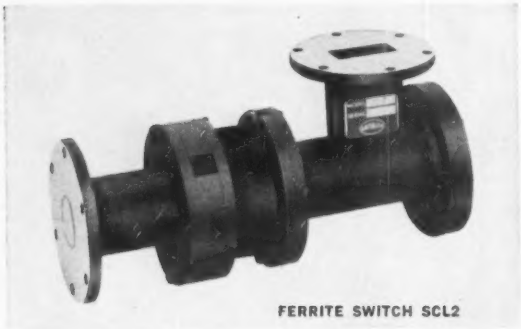
# THREE-POSITION FERRITE SWITCH FOR C-BAND




TYPICAL MICROWAVE CIRCUIT in which Raytheon ferrite switch is now being used. Switch has three positions: antenna to main channel; antenna to standby channel; antenna to both channels simultaneously.




FERRITE SWITCH IS ACTIVATED when fault is detected in sensing unit. Receiver fault causes switch to transfer to intermediate position for comparison of main and standby. Normal baseband receiver noise and pilot tone allow switch to complete switchover.

**TYPICAL SPECIFICATIONS**

| | SCL2 |
|---|---|
| *Frequency range (mc)* | *6,575-6,875* |
| *Isolation, minimum* | *20db* |
| *Isolation, maximum* | *30db* |
| *Insertion loss, minimum* | *0.5db* |
| *Insertion loss, maximum* | *0.8db* |
| *Power, average* | *10 watts* |
| *Power, peak* | *1 kw* |
| *VSWR, minimum* | *1.02* |
| *VSWR, maximum* | *1.28* |
| *Type of switch* | *SPDT reciprocal* |
| *Coil current* | *400 ma* |
| *Coil resistance* | *60 ohms* |
| *Length* | *8 in.* |
| *Waveguide* | *RG-50/U** |

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## ADVANCED SWITCHOVER PROTECTION PERMITS MORE RAPID AND FLEXIBLE OPERATION THAN EVER BEFORE

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3. antenna to both channels simultaneously

In the third position, the received signal is divided equally between the arms feeding the main and standby receivers.

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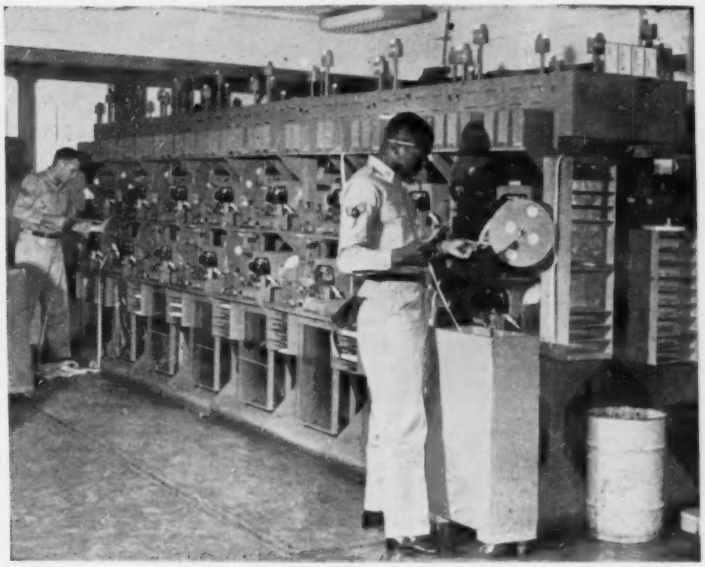
# U. S. to Use More Computers

## Federal spending for electronic data processing gear is $50 million—up 150% in 2 years



Armed services have long been heavy users of computers. Above: Air Force personnel are busy at a system's "repeater bank"

FEDERAL OUTLAY for renting electronic data processing systems will run close to $50 million this year, an increase of $30 million— or 150 percent—since 1957.

Two years ago federal agencies were operating about 121 computer installations. The present number in use is more than 175.

Payroll for personnel to operate this equipment, estimated at about $27 million in 1957, is expected to top the $80 million mark by 1963.

This information, as well as other facts, emerges from testimony given to the House of Representatives subcommittee on Census and Government Statistics.

### *Savings Cited*

A reason for the increase in spending for computers and other edp gear is the substantial savings reported by departments, once the electronic gear is put in operation.

The Treasury Department shows savings of about $2 million annually resulting from computer processing. The Social Security Administration reports close to $1 million savings a year in processing work electronically instead of manually. Savings of similar magnitude are reported by other federal groups.

A sizable percentage of the cost reductions are traced to reductions in personnel made possible through the use of computers. Additional savings came about through faster record posting, information retrieval and arithmetic processing.

One area slated for additional study by the investigating group concerns decisions regarding purchase vs. lease of computer equipment.

### *Leasing Most Likely*

Many department heads fear that purchase of equipment might be unwise because of the rapid pace of today's computer technology.

Spokesmen before the group cited several instances where federal departments purchased equipment, only to find that later refinements in technology rendered their purchases obsolete. From all indications, it appears likely that leased rather than purchased equipment will be used for quite some time to come.

Centralized facilities will most likely be emphasized in the obtaining of equipment. Subcommittee members are particularly interested in making certain that as much doubling up as possible will come about to insure maximum operational usage for all new edp purchases. Federal personnel will be instructed to make careful studies along these lines.

### *Personnel Needed*

In commenting on this subject a spokesman for the General Accounting Office says: "We find that the degree of success in working with this equipment is directly related to the amount of pre-planning and study that goes in before the acquisition of the equipment. There is a direct relationship."

Another area requiring intensive study is edp personnel recruitment. Department heads have found that more is involved than a mere shifting of available personnel. Attempts to do this were made by the General Accounting Office and the Treasury Department.

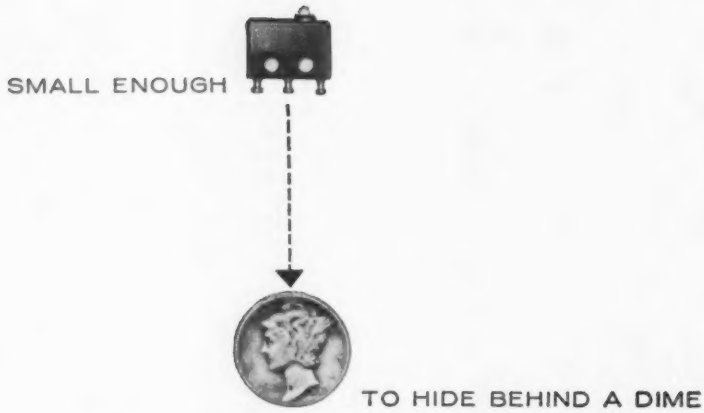
The results of one aptitude test: Total tested — 303; selected for training — 51; completed training —15.

Similar results were obtained from other attempts.

Spokesmen from several departments indicated that unless additional training is made available by academic institutions and computer manufacturers, the supply of skilled personnel in the edp field will become critically low.

Reason cited as creating the increased personnel requirements is the growing potential of computers in such applications as price support computations, soil bank and wool program accounting.

Also mentioned before the committee was increased government participation in road and bridge design, housing research and engineering and the processing of statistics related to this field.

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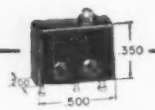



**CASE SIZE**: .500″ x .200″ x .350″—ten to the square inch.

**WEIGHT**: 1 gram—28 switches to the ounce.

**ELECTRICAL RATING**: 28 vdc: 7a. resistive, 4 a. inductive—sea level; 2.5 a. inductive—50,000 ft.; 4 a. motor load, 2.5 a. lamp load, 24 a. max. inrush. 115/230 vac: 60 to 400 cycles: 5 a.; 15 a. inrush.

**MECHANICAL LIFE** is in the millions of operations.

The case of the 1SX1 has two through holes that accept #2 screws. One hole is slightly elongated to facilitate mounting.

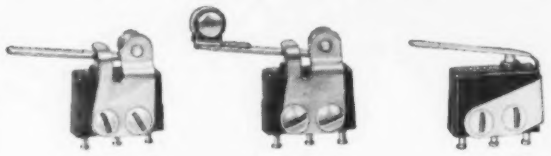
The 1SX1 operates dependably in temperatures from −65°F to +250°F. Operating force is controlled and predictable within 3 oz. to 5 oz. limits.

For more information about this important switch, ask for Catalog 63.

MICRO SWITCH field engineers will be glad to provide application assistance and give you full information on this sub-subminiature switch and its actuators. Call your nearby MICRO SWITCH branch office.

## Now offered with six actuators

These actuators are offered in four basic designs and, in addition, two reversed actuators are offered which provide lower free position and reduced pre-travel.



Pivoted lever actuator | Pivoted roller lever actuator | Leaf actuator

Roller leaf actuator | Reverse leaf actuator | Reverse roller leaf actuator

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CIRCLE 41 ON READER SERVICE CARD→

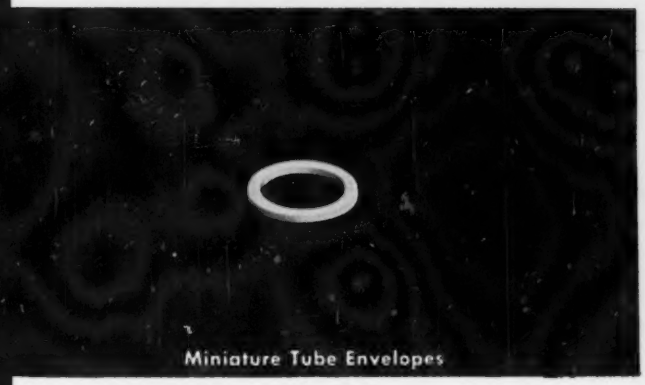
# Precision Is The Standard At Coors

Ceramic Wafers for Micro-Modules

## Micro-Module Wafers

The hottest news in extreme miniaturization of electronic equipment is the micro-module—an amazingly small combination of sub-miniature electronic circuit components. The fundamental unit of a micro-module is the high alumina ceramic base plate—a tiny ceramic wafer, approximately 0.300" square x 0.010" thick. Upon this is deposited or metalized a component of a circuit—a resistor, capacitor, transistor, diode, etc. The micro-module is a combination of several of these elements in a small space to serve a specific circuit function—amplifier, oscillator, etc.

Coors is manufacturing these precision wafers in large quantity production runs for several manufacturers working on the same project. Coors holds all dimensions of the tiny ceramic wafer to extremely close tolerances so that the micro-elements produced from them are entirely interchangeable from manufacturer to manufacturer



Miniature Tube Envelopes

## Tube Envelopes

Coors makes high strength ceramic envelopes to extremely close dimensional tolerances and in a wide range of sizes for use in modern electron tubes. Certain of the Coors ceramic compositions were developed specifically to meet the rigorous operating conditions and reliability requirements to which high power, high frequency tubes are subjected.

Illustrated here is one of the miniature ceramic envelopes in regular production. Coors regularly produces many other sizes up to 10" O.D. Larger sizes can be manufactured.

Coors ceramics have outstanding electrical and physical characteristics. These properties are not affected by high outgassing or high operating temperatures.

**LOWER COSTS for Precision Ceramic Parts Through Quantity Production**—Coors has been able to make substantial reductions in manufacturing costs by stepping up production of high precision parts through automation.

All this adds up to these advantages for you: 1. Faster delivery on large quantity orders. 2. Precision parts—uniform and interchangeable, permitting you to use them on a production basis. 3. Prices that are correspondingly low.

For further information about Coors Space Age Ceramics and for a complete description of physical properties, write for Bulletin 858.

Ceramic-to-Metal Standard Terminal Insulators

## Standard Terminal Insulators

Coors furnishes *standard* terminal insulators—available from stock—in various ratings and, also, can manufacture custom made insulators to meet your specific requirements. In the range of standard sizes, metal parts are bonded to the ceramic by Coors High Temperature Metalizing Techniques, thus producing strong hermetic ceramic-to-metal seals. The result is standard terminal insulators available for a wide range of requirements—insulators that have superior electrical and mechanical characteristics. Production is on a large quantity basis—you do not pay a premium for high quality, precision terminals.

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# Magnetic Devices

## Washington conference gives 400 engineers newest data on developments, applications

WASHINGTON—RUNDOWN on latest developments with parametrons in Japan, description of a fast, high-density vacuum-evaporated magnetic memory, and use of magnetic amplifiers with high-power silicon transistors in missile control circuits were among the high points of the 1959 Technical Conference on Nonlinear Magnetics and Magnetic Amplifiers here recently.

Sponsored by the AIEE and the IRE, the conference attracted some 400 engineers and featured 25 papers.

H. F. Storm of GE, who returned recently from Japan, discussed the state of the magnetic art there.

He said a considerable effort is being made to sell parametrons in this country. Storm said an assembly consisting of 25 parametrons including tank capacitors and resistors sells for approximately $20.

### *Describes Circuit*

C. L. Boyajion of GE discussed the operating characteristics of the transfluxor and analog memory circuit. K. D. Broadbent of the Hughes Research Laboratories presented a description of a vacuum-evaporated random-access memory matrix. The matrix consists of a multipath evaporated magnetic structure and multiple evaporations of insulating and conducting materials, and features magnetic turnover less than 80 millimicroseconds, wide latitude in selection currents and a typical volume of 0.25 by 0.100 by 0.007-in. per bit.

B. Mokrytzki and R. A. Stuart of Westinghouse, described a magnetic amplifier-silicon transistor power supply for a missile application. The use of high-power silicon transistors in combination with magnetic amplifiers resulted in a highly efficient, well regulated, rugged unit capable of operating reliably over a wide range of temperatures, the authors said.

Lovell of MIT showed a model developed by D. Woodson (also of MIT) for a saturable reactor core and indicated how it is used to explain the operation of multicore and polyphase magnetic amplifier circuits.

The effects of environment on magnetic properties of toroidal cores, and the effects of vibration, shock, acceleration and temperature on the magnetic characteristics of tape core material, were discussed by J. E. Mitch and H. A. Lewis of Arnold Engineering.

## Contract Proposals Losing You Sales?

BOSTON — "Oversimplification is most frequently the Navy's reason for rejecting an R&D contract proposal. Professional integrity and technical honesty count most. Technical dishonesty shows up when problem areas are minimized, ignored or camouflaged.

"Omit the sales talk—we've heard it before," advised Capt. Frank W. Evans of the Office of

## Explosive Forming

**Man-made lightning triggers underwater explosion that bulges an aluminum tube with 6,000-hp force, during demonstration at Republic Aviation. Firm hopes to use technique in a machine tool for forming such space-age metals as steel and titanium alloys**

# Revealed

Naval Material. He addressed the Boston session of the national symposium conducted by the IRE Professional Group on Engineering Writing and Speech.

Other tips to proposal writers: Proposals are not judged by weight —don't send a truckload; they should be written on the working-engineer level, with a one-page summary for executive personnel; don't copy chunks of the military specs; use simple, precise language; don't underestimate costs; use color only if significant for the R&D problem; put into the cost of preparing your proposal only as much money as the company can afford to lose on it.

James Girdwood, publisher of ELECTRONICS, spoke on "Technical Journalism and the Business Press." Pointing out there are 2,000 business publications in the U. S., he said this dissemination network is peculiar to the U. S. and is obviously related to its primacy in production.

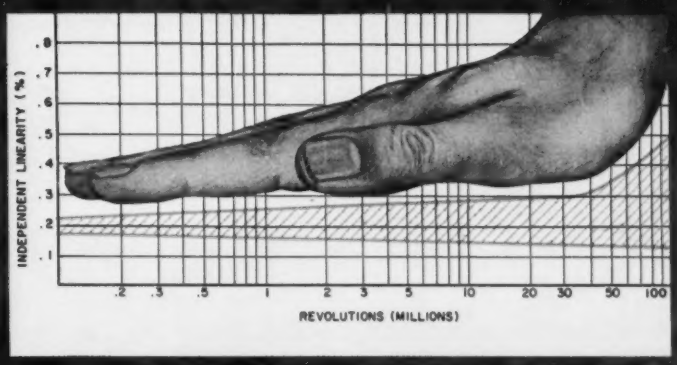
### *Supports Industry*

Chief aim of the business press, Girdwood said, is to advance the status of the industry it serves. "It deals directly with the reader's interest in his job and his business. Its specific obligation to the reader is in providing valuable editorial material in return for an investment—the reader's time as well as the subscription cost."

Publication of an idea lends validity, he said, "and it is our obligation to edit against this standard."

Trade publications, Girdwood said, are vital tools of communication: "How effective they are depends on the writing engineer."

He urged engineers to contribute to the communications system by writing articles, keeping in mind the specific audience the publication has. Demands on time have doubled in the past decade, he said, so engineering publications cannot use lengthy treatises. Technical articles must appeal to broad interests. "Write to whet the interest of our best engineers and you'll interest the rest," he said.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## *how will it affect your business?*

General Electric's revolutionary Silicon Controlled Rectifier was introduced just two short years ago. The SCR has already proved it lowers costs, improves performance and solves old problems in radically new ways. It can replace thyratrons, magnetic amplifiers, power tubes and transistors, relays, switches, and many other devices. These are a few of the changes the SCR is now bringing about:

Vastly superior motor control systems for industry. Faster, more precise, smaller, more versatile, non-mechanical.

AC current for vehicles and aircraft. The SCR is the first really practical means of getting high power AC from variable DC. Static inverters with ratings of several kilowatts are possible.

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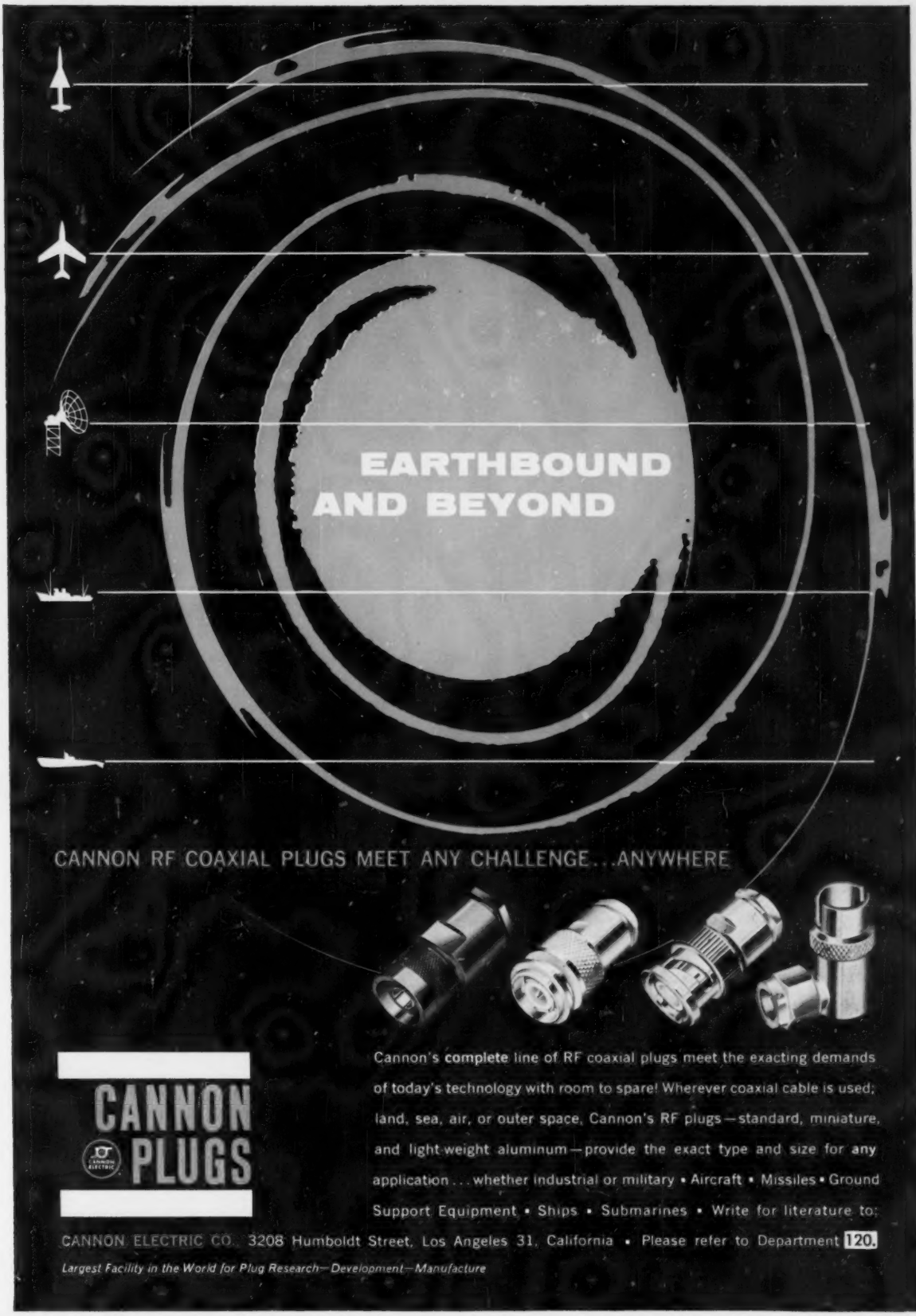


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*Old and new—At left, a present semiconductor. At right, dendritically grown germanium crystals which perform the same function. Westinghouse expects to build several different electronic functions into single tiny slabs like these.*

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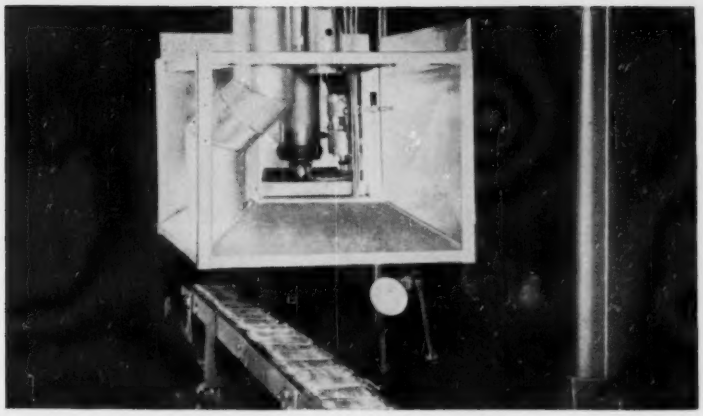


**Tests on storage potential of irradiated food have been encouraging. Midwest Irradiation Center rents its reactor for $100 per hour**

# Electrons Aid Food Storage

By L. G. SANDS, Consultant, Ridgewood, N. J.

TODAY'S FOOD FREEZERS may someday be replaced by electron accelerators. Successful experiments in food preservation by irradiation have been going on for some time, but the Midwest Irradiation Center's recent announcement that its accelerator will be available to all food industries indicates a definite speed-up in the experimental program.

Intensive testing of the storage potential of irradiated food has been carried on by the U. S. Quartermaster Corps. Results have been so encouraging that approval by the U. S. Food and Drug Administration would almost certainly open this new area of food preservation to commercial use.

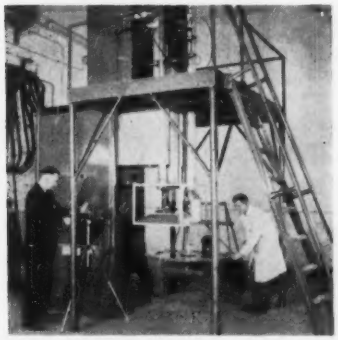
Experiments have shown that meats can be processed, irradiated and stored for extended periods of time. Milk and other canned goods can be pasteurized in their containers.

According to *Food Engineering* (a McGraw-Hill publication), the taste of some foods is changed by irradiation. However, this may not have a serious effect on the technique's commercial possibilities since the taste of some products changes under ordinary refrigeration without hurting their marketability.

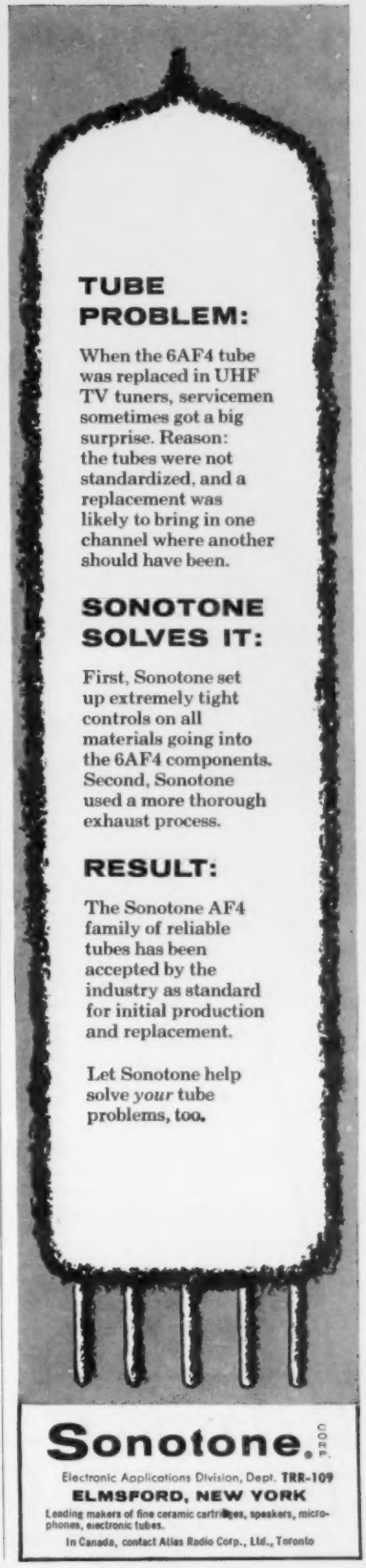
The machine shown on the cover of this issue is the Applied Radiation Corp.'s 8-million-electron-volt linear accelerator. The machine cost $175,000. Another $45,000 was spent for shielding.

A 10-microsecond electron burst is fed through an aperture in a klystron into the accelerator waveguide. The electrons reach a speed close to the velocity of light, and the electron beam energy may be as high as 9 mev. The beam, 1 centimeter wide at the window at the output end of the waveguide, flares out to 8 cm.

The beam can irradiate materials of unit density up to thicknesses of 1 in. Materials two inches thick can be penetrated by irradiation from both sides. The beam energy can be adjusted to vary the depth of penetration. A tungsten target converts the beam into X-rays, which are more penetrating than gamma rays of cobalt-60.



**THE FRONT COVER—Rockford, Ill., accelerator is being prepared for food irradiation test. $175,000 machine is operated by the W. F. Barnes Co. and Applied Radiation Corp.**



TUBE PROBLEM:
When the 6AF4 tube was replaced in UHF TV tuners, servicemen sometimes got a big surprise. Reason: the tubes were not standardized, and a replacement was likely to bring in one channel where another should have been.
SONOTONE SOLVES IT:
First, Sonotone set up extremely tight controls on all materials going into the 6AF4 components. Second, Sonotone used a more thorough exhaust process.
RESULT:
The Sonotone AF4 family of reliable tubes has been accepted by the industry as standard for initial production and replacement.
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## *to solve timing problems*

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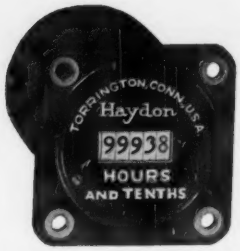


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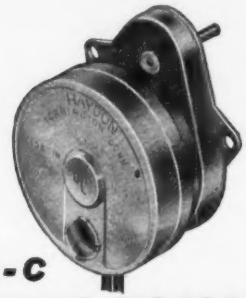

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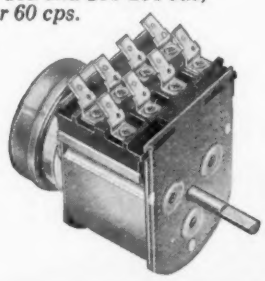
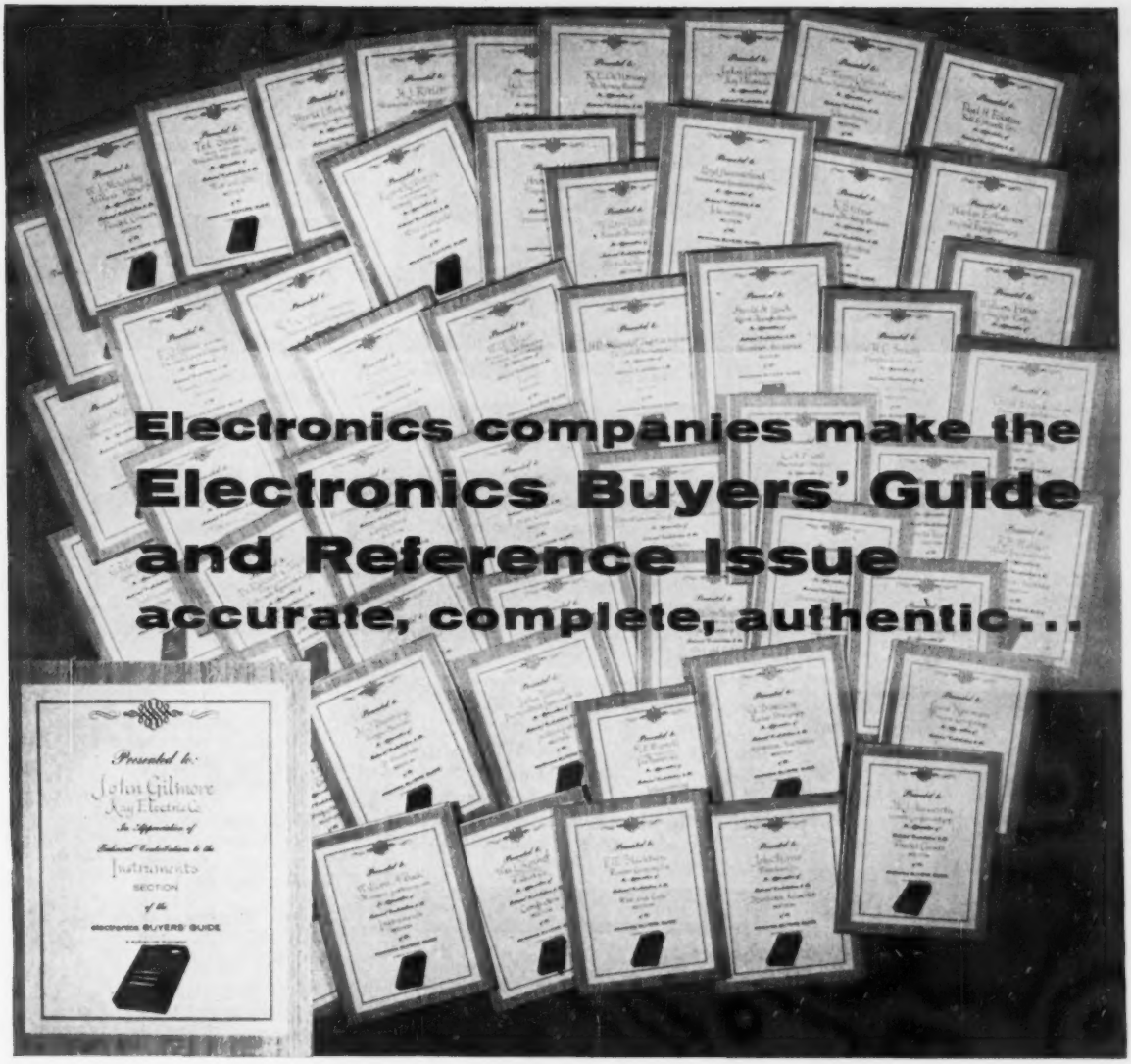


### INTERVAL TIMER

*Directly controls heavy duty electrical loads. Type AD can be supplied with up to 3 SPST switches. Type AT has 1 SPST switch only. Intervals available with dial and knob: 15, 60 and 180 minutes. Intervals to meet your specific requirements can be supplied. Voltages: 120 or 240 v, 50 and 60 cps. Switch Rating: 28 amps, 250 vac non-inductive; 1 hp, 240 vac.*




For nineteen years, firms in the electronics industry have made direct contributions to the accuracy, completeness and authenticity of the BUYERS' GUIDE.

Recently, the staff of the BUYERS' GUIDE decided to award plaques to express appreciation to those in the industry who had made direct contributions to improve the product listings. The photograph above represents a few of the awards that have been made.

The awarding of the plaques is but one indication of how the BUYERS' GUIDE evolved over the years . . . a *cooperative effort between the publication and the industry it serves.*

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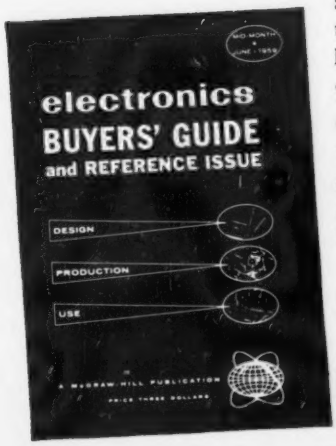


**Published mid-year as the 53rd issue of electronics**

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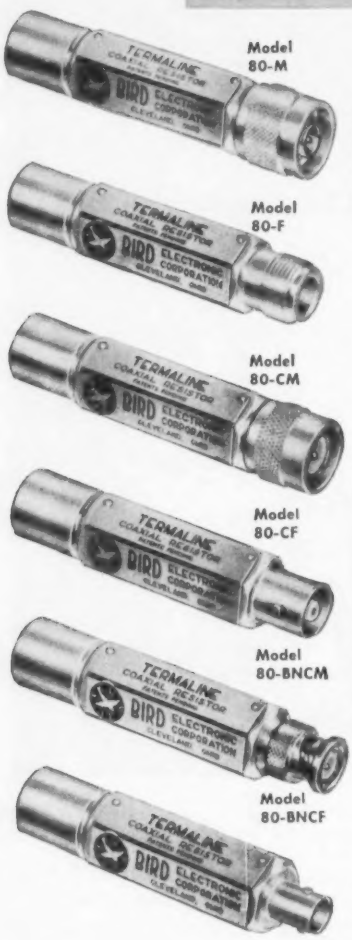
# BIRD

## "Termaline" 50 ohm Coaxial Line 5-WATT LOAD RESISTORS




### A Known Factor

In measurements of 50-ohm coaxial systems, the Bird 5-watt coaxial terminations provide a known factor.

As primary test equipment in field or laboratory, they are used as . . .

- 50-ohm impedance standards;
- terminations for slotted lines;
- measurements of filter characteristics.
- terminations for insertion loss measurements, and;
- other measurements where an accurate and reliable 50-ohm termination is required.

The low VSWR of the 5-watt "Termaline" resistors, their ability to withstand vibration, and their compactness in size makes their use applicable to a variety of electronic systems where a reliable 50-ohm termination is required.

### SPECIFICATIONS

**POWER RATING:** 5 Watts Max.
**NOMINAL IMPEDANCE:** 50 ohms
**USEFUL FREQUENCY RANGE:** 0 to 11,000 mc
**VSWR:** 1.2 Max. to 4000 mc
1.1 Max. under 1000 mc
**SPECIAL VSWR:** Can be provided
**OPERATING POSITION:** Any
**CASE:** Brass **FINISH:** Silver Plated
**LENGTH:** 3-3/8" Max.
**WIDTH:** 11/16 Hex.
**WEIGHT:** 4 ounces

OTHER BIRD PRODUCTS

"Termaline" RF Load Resistors | Coaxial RF Filters | "Thruline" Directional RF Wattmeters | Coaxial RF Switches | "Termaline" RF Absorption Wattmeters

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## MEETINGS AHEAD

**Oct. 11-16:** American Institute of Electrical Engineers, Fall General Meeting, Hotel Morrison, Chicago.

**Oct. 12-14:** National Electronics Conference, AIEE, EIA, IRE, SMPTE, Hotel Sherman, Chicago.

**Oct. 12-16:** Aeronautics and Space Administration Inspection, NASA, Langley Research Center, Norfolk, Va.

**Oct. 14:** Institute of Printed Circuits, Fall Meeting, Sheraton Towers, Chicago.

**Oct. 14:** Medical Electronics, Evaluating Cardio-Vascular Function, PGME of IRE, Moore School, Univ. of Penn., Philadelphia.

**Oct. 19-21:** National Academy of Sciences, Research Council, URSI, IRE, Fall Meeting, El Cortez Hotel, San Diego, Calif.

**Oct. 19-22:** Semiconductor Symposium, Fall Meeting, Electrochemical Society, Deshler-Hilton Hotel, Columbus, O.

**Oct. 26-28:** Aeronautical & Navigation Electronics, East Coast Conf., PGANE of IRE, Lord Baltimore Hotel, Baltimore.

**Oct. 28-29:** Michigan Industrial Electronics Exposition, Electronics Representatives Inc., Detroit Artillery Armory, Oak Park, Mich.

**Oct. 29-30:** Electron Devices Meeting, PGED of IRE, Shoreham Hotel, Washington, D. C.

**Nov. 3-5:** Mid-American Electronics Conf., MAECON, Municipal Auditorium and Hotel Muehlenbach, Kansas City, Mo.

**Nov. 4-6:** Automatic Control, National Conf., PGAC & PGIE of IRE, Sheraton-Dallas Hotel, Dallas.

**Nov. 5-6:** Instrumentation Conf., School of Engineering, Louisiana Polytechnic Institute, Ruston, La.

**Nov. 9-11:** Radio Fall Meeting, IRE, EIA, Hotel Syracuse, Syracuse, N. Y.

**Nov. 9-11:** Instrumentation Conf., PGI of IRE, Biltmore Hotel, Atlanta.

**Mar. 21-24, 1960:** Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 92.

# L-BAND KLYSTRON DELIVERS 10 MEGAWATTS (minimum!)

This member of Litton Industries' klystron family is indeed a big brother. The L-3250 produces a peak power output of 10 MW at an average power output of 15 kw. Now in production for a major early warning radar system, this klystron promises to equal the performance and reliability record of its predecessors. Litton Industries' generic klystron, the 2.2 MW L-3035, has delivered full performance for over 8,000 hours. The average operating life being obtained in field service is now approaching 3,000 hours and increasing daily.

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The long life obtained in these tubes provides low cost per operating hour which, combined with low initial cost, places linear accelerators within reach of many new users.

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The performance of our L-band klystron family has made Litton Industries the leading supplier of high powered klystrons in this range. Soon comparable families at other frequencies will enhance the reputation gained at L-band.

For your present needs, whatever your requirements for high power, be they radar, linear acceleration, or others, Litton Industries is *the* supplier. For your future needs, it's best to get our thinking early in your planning. Write to Litton Industries, Electron Tube Division, Office E21, 960 Industrial Road, San Carlos, California.

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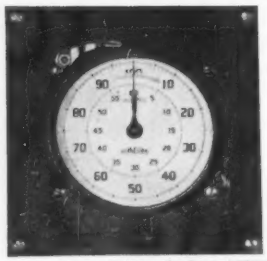

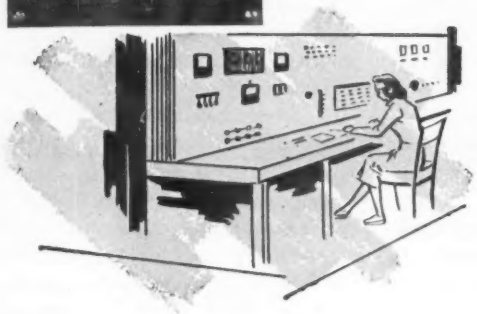

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| S-6 | 1/1000 min. | 10 min. | ±.0002 min. |
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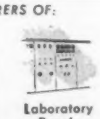
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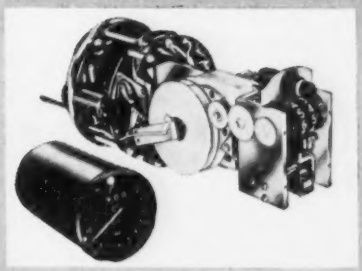
A HOFFMAN SEMICONDUCTOR APPLICATION CASE HISTORY

# THIS VOLTAGE STABILITY PROBLEM HAD TO BE SOLVED

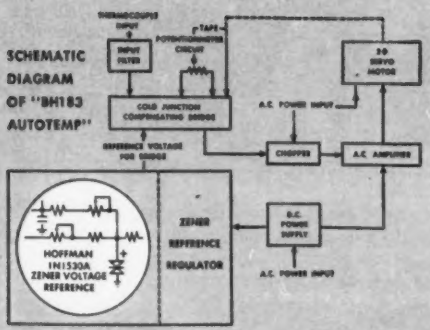
VISIT BOOTHS
NOS. 227-228
AT THE NEC SHOW

## FOR CIRCUIT RELIABILITY IN A JET ENGINE TEMPERATURE INDICATOR



***Hoffman Zener Voltage Reference Elements were the solution***

SCHEMATIC DIAGRAM OF "BH183 AUTOTEMP"




Engineers of the B & H Instrument Company, Fort Worth, Texas, required an extremely reliable voltage reference device for their BH183 AutoTemp jet engine temperature indicator, used in the Lockheed Electra. . . . They chose a Hoffman 1N1530A Zener Reference Element, because of its STABLE characteristics even when subjected to widely varying environmental conditions.

The low 8.4 volt, zener operating voltage of Hoffman 1N430 and 1N1530 Zener Reference Elements, makes them uniquely suited for use in circuits which are operating at a low D.C. voltage level (from 10 to 30 volts). The units have a voltage stability of $\pm 0.1\%$, or less, over a temperature range from $-55°C$ to $+100°C$, at 10mA.

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# Design around Mallory

## for new

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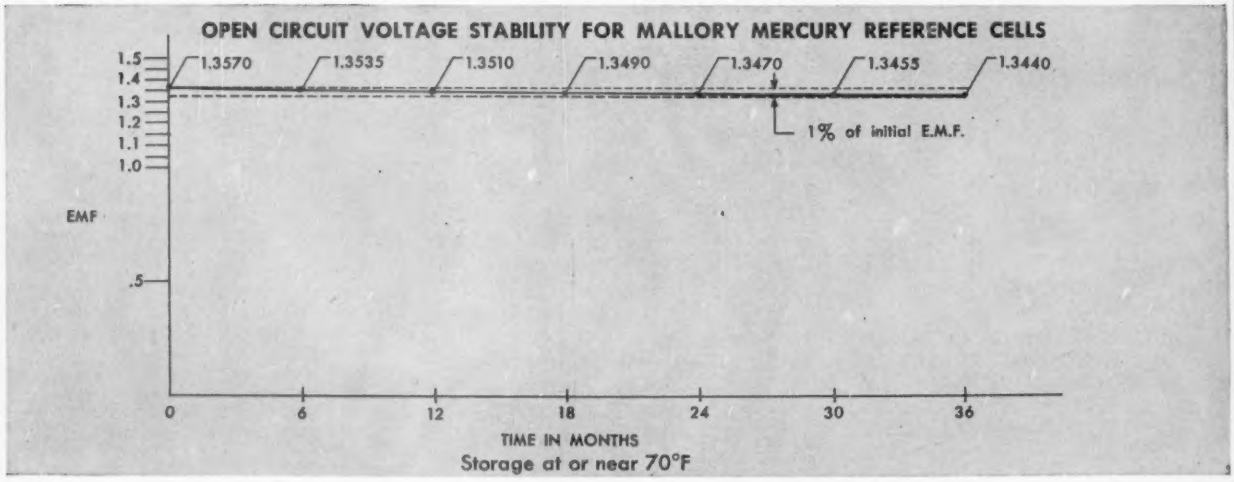


**For Steady Output**—Highly constant output voltage of mercury batteries makes them valuable as reference sources in instrument circuits. The curve shows how open circuit voltage keeps within 1% of original value during 36 months storage. Exceptionally high accuracy can be obtained for short run service under load, as in missile telemetering, by calibration prior to use in the intended circuit.

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**Want greater convenience?** Long lasting mercury batteries greatly reduce frequency of battery change.

**Want dependability?** Mallory mercury batteries last up to four times longer in service than conventional types . . . can be stored for up to six years without appreciable loss of capacity. They operate over wide temperature ranges.

**Want stability?** Output stays so constant that they can be used as reference voltage standards. Constant voltage discharge is ideal for transistor circuitry.

The applications pictured here are typical of the ways that Mallory mercury batteries are adding new values to self-powered products. Let's get together on how we may help you, too . . . either by applying our line of standard batteries or by developing custom-made packs for you.

Mallory Battery Co., Cleveland, Ohio

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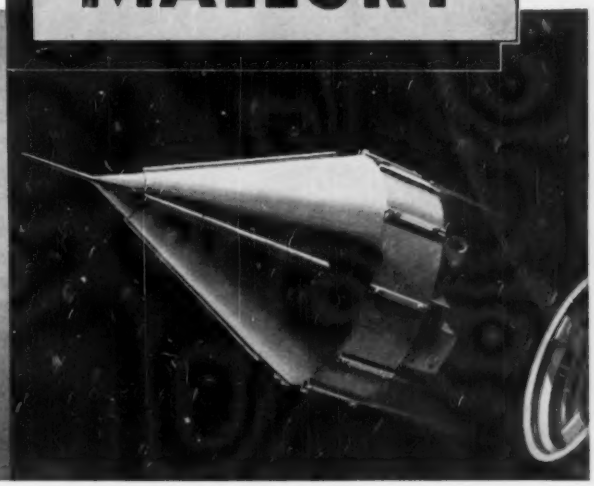
**For Dependability**—"Atronic Pacer/Monitor"—pocket-size electronic heart stimulator, made by Atronic Products, Inc., supplies pulses that prevent heart slowdown in cardiac patients . . . lets them live useful lives away from a hospital bed. Life-saving impulses are powered by Mallory mercury batteries, which deliver constant power for months in this critical service.



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**electronics**
OCTOBER 9, 1959

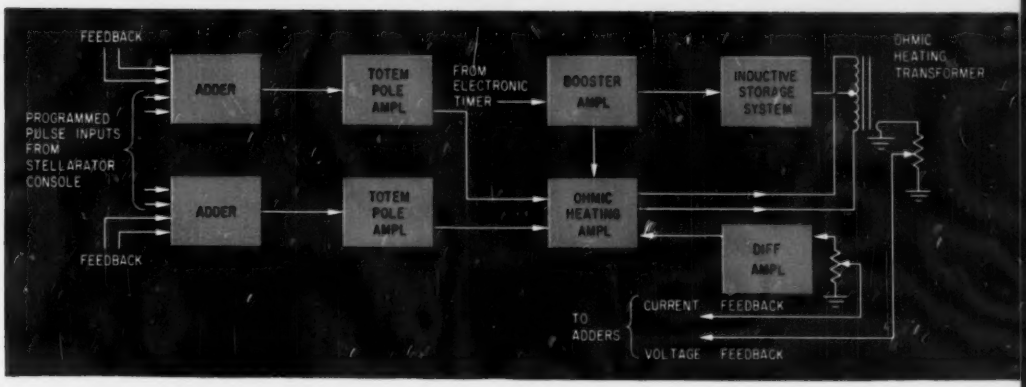



**FIG. 1—Ohmic heating system develops 1.2 megavolt-amps at audio frequencies**

# Ohmic Heating Circuits For Plasma Physics

**Audio generator heats stellarator plasmas to one million degrees C during thermonuclear fusion process. Experimental system produces 1.2 megavolt-amperes at 0 to 20 kc**

By **RODGER L. GAMBLIN***, Project Matterhorn, Princeton University, Princeton, N. J.

CONTROLLED THERMONUCLEAR POWER production requires maintaining a plasma of hydrogen isotopes at temperatures near one hundred million degrees C for an appreciable fraction of a second. One approach to this goal is through the use of stellarators (ELECTRONICS, p 75, Dec. 19, 1958).

Hydrogen gas is confined in the stellarator by a twisted, toroidially-shaped magnetic field of 20,000 gauss or greater. Initially, electric fields are applied parallel to the magnetic field to ionize and heat the gas. First an r-f field partially ionizes the gas, then a d-c or audio signal completes ionization and raises the resulting plasma to $10^6$ C. The circuit to be described generates the d-c signal. The r-f generator was described in an earlier article (ELECTRONICS, p 50, July 3, 1959).

**OHMIC HEATING**—The d-c or audio signal used to heat the plasma is called the ohmic heating pulse. Normally, it consists of an arbitrary waveform of up to five milliseconds duration. The B3 stellarator, for which the ohmic heating equipment was designed, has a vacuum chamber five cm in diameter and 640 cm long with an inductance of four $\mu$h. During operation, the vacuum tube is filled with ionized gas of such conductivity that the resistance offered to passage of the ohmic heating current may drop to 10 milliohms from an initial value of one ohm.

The twist of the confining magnetic field tends to be unwound, or wound up to 2 $\pi$ radians, by the cir-

*Now with International Business Machines Corp., Endicott, N. Y.

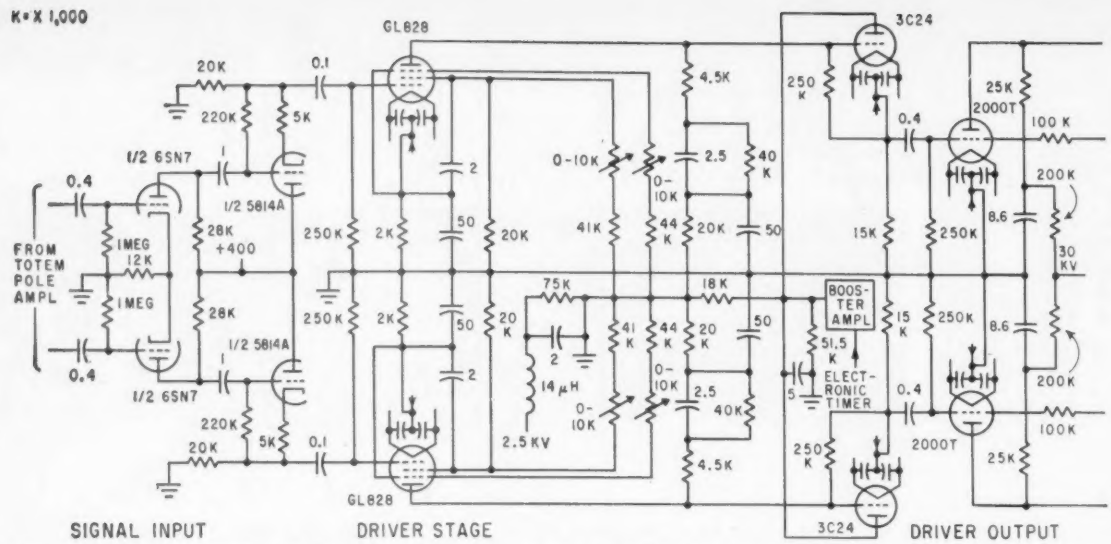



FIG. 2—Ohmic heating amplifier delivers high-power, finely-controlled audio signal to hydrogen plasma. Plasma is shown as single turn

cular magnetic field produced by the ohmic heating current. When the twisting effect of the stellarator becomes completely neutralized, the plasma becomes hydromagnetically unstable and can no longer be confined. In the B3 stellarator, maximum permissable current before onset of this instability at a confining field of 60,000 gauss is 6,000 amp. Such a current level is generally the maximum desirable stellarator current.

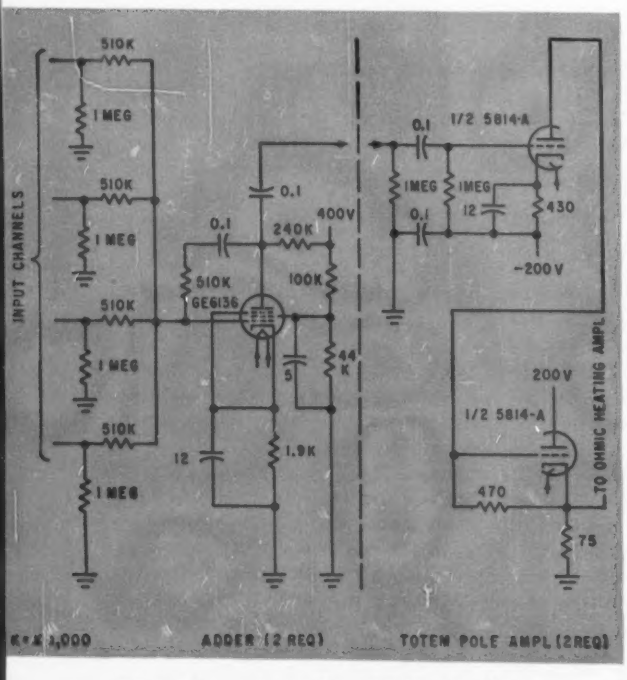
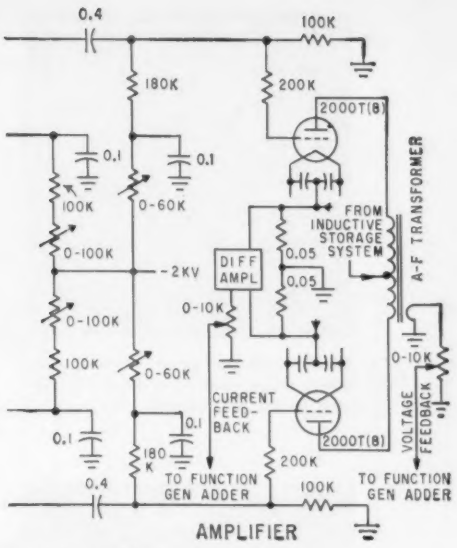



FIG. 3—Totem pole amplifier minimizes distortion

When the ohmic heating pulse is applied to the stellarator, each electron gains energy which it dissipates in collisions with ions or neutral particles. The higher the energy of an electron, however, the smaller its collision cross section. If the voltage applied to the stellarator is too high, then some electrons gain so much energy between collisions that they escape because of the decline in collision cross section. Primarily because of this problem, but also for other reasons dictated by the physics of the stellarator and needs for observation, it is desirable that the ohmic heating apparatus apply an arbitrarily-shaped waveform to the plasma. Figure 1 shows the basic block diagram of the ohmic heating system.

**DESIGN REQUIREMENTS**—Two modes of stellarator operation are needed: constant voltage and constant current. In the first mode, it is necessary to apply a voltage waveform closely approaching the input irrespective of the plasma impedance. In the second mode, it is desired that the plasma current approximate the input voltage waveform. For d-c pulse conditions (square unidirectional waveforms up to five milliseconds in duration) the ohmic heating pulse needs to be less than 200 v, indicating a power level operation of 1.2 megavolt-amperes. For operation at 10 kc, the voltage output needed is on the order of 680 v; however, since the plasma impedance increases because of inductive effects, total power requirements are comparable to the d-c case.

Thus, the requirements for an ohmic heating system are that it be able to operate at a power level of 1.2 megavolt-amperes at any frequency ranging from zero to 20 kc into a load that varies from $1 + j0.2$ to $0.01 + j0.2$ ohms. Since the possibility of operating the system with a capacitor tuning the inductance of the plasma is precluded by flatness requirements of frequency response and by a minimum rise time re-




on output transformer

quirement, the output must operate into an inductive load. The amplifier must have an internal impedance small compared to 0.01 ohm for constant voltage operation and large compared to one ohm for constant current operation.

**OHMIC HEATING AMPLIFIER**—Figure 2 shows the basic circuit of the ohmic heating amplifier. A primary design criterion for the amplifier is the stability of the feedback loop. It has been shown that when an amplifier consists of a number of stages of nearly identical frequency response, and of one low-pass stage, an approximate criterion for stability is that the feedback factor $|A\beta|$ be less than the ratio of the frequency response of the high-pass stages to that of the low-pass stage. Since feedbacks on the order of 22 db are needed in the ohmic heating system, a frequency response ratio of 20 was selected. All stages, except the driver, are at least 180 kc and the latter is 9 kc. Since the driver is capable of a higher pass output, 200,000-ohm resistors are in series with each grid of the final stage. The rise time of the amplifier with voltage feedback is near 10 $\mu$sec, indicating an approximate bandpass of 50 kc.

The physical location of the feedback pickup loop requires that the signal be transmitted over 50 ft to couple with the amplifier. A totem pole amplifier, shown in Fig. 3, was selected to minimize distortion in driving the return coaxial cable.

**OUTPUT STAGE POWER SUPPLY**—The power supply for the output stage consists of a shunt-regulated, electronically-switched inductive energy storage system shown in Fig. 4. Coil $L_1$ is charged through the vacuum switch. Just prior to operation of the ohmic heating system the grid of $V_1$ is pulsed positive and simultaneously the vacuum switch is opened. Tube $V_1$ breaks down as the switch opens. When the high voltage is needed, $V_2$ is fired and the negatively-charged capacitor in its cathode puts an inverse voltage on $V_1$ that de-ionizes it. The capacitor in the cathode of $V_2$ is then charged up by the coil current until the system reaches 20,000 v, at which time the regulator starts operating and maintains the voltage constant.

An electronic feedback regulator in shunt with coil $L_1$ draws current so that the output voltage is maintained constant at 20,000 v.

The ohmic heating system has been operating since Aug. 1958. It was supported under contract AT(30-1)—1238 with the Atomic Energy Commission.

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T. Coor, S. P. Cunningham, R. A. Ellis, M. A. Heald and A. Z. Kranz, Experiments on the Ohmic Heating and Confinement of Plasma in A Stellarator, *The Physics of Fluids*, **1**, No. 5, Sept.-Oct. 1958.

R. L. Gamblin, The Design and Operation of a 25,000-Joule Inductive Energy Storage System, Paper V-100, *Nuclear Engineering and Science Conference*, Cleveland, Ohio, 1959.

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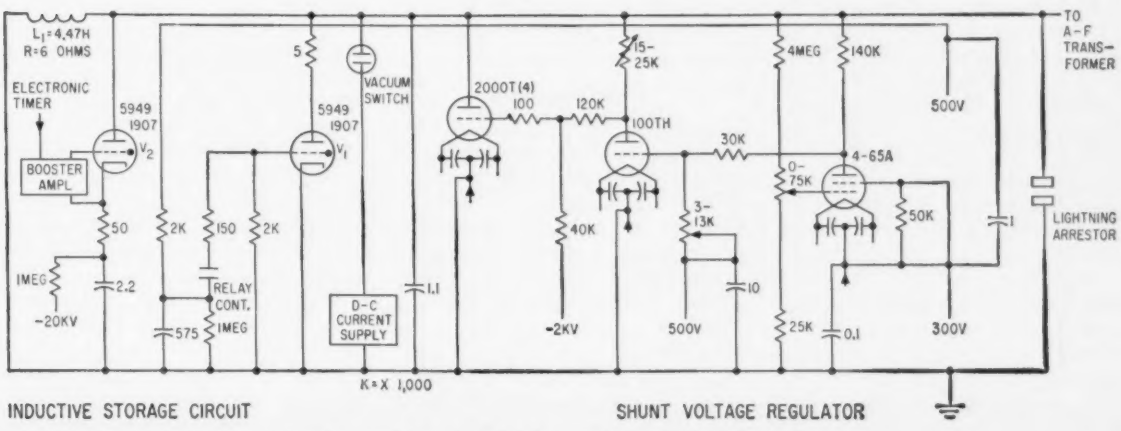
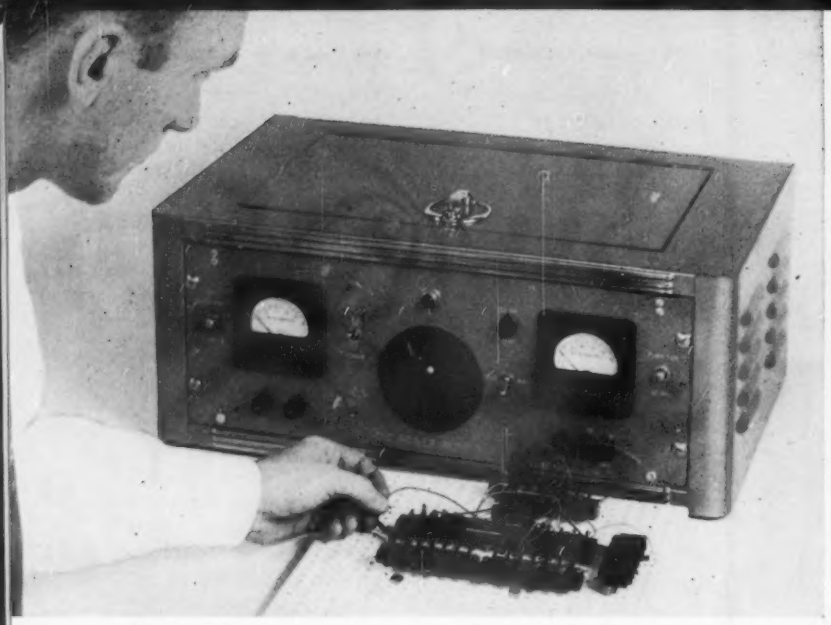



FIG. 4—Inductive storage system provides power for ohmic heating amplifier output stage



Experimental circuit is tested, using the closely regulated supply as a reliable source of constant voltage power

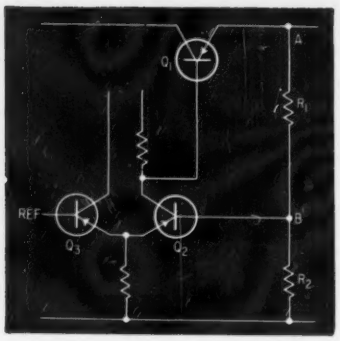



FIG. 1.—Error voltage of series-regulated power supply appears at point $B$ attenuated by the $R_1R_2$ network

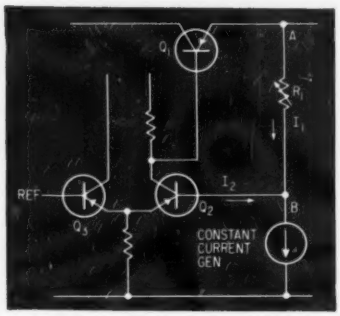



FIG. 2—Constant current circuit allows total error to appear at $B$

# Constant-Current-Coupled

## By driving a constant current through a fixed resistance, the total error voltage of a power supply can be fed into an error-correcting amplifier


**By EDWIN GORDY and PETER HASENPUSCH**

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SERIES REGULATED power supplies operate on the principle of using an error signal to control the series regulating device. If the gain of the control loop can be increased, the load regulating characteristics of the power supply can be improved. A similar improvement in regulation can also be obtained if the error voltage is sampled without attenuation by the customary resistive divider network.

The basic circuit of a conventional series regulated, transistor power supply is shown in Fig. 1. Transistor $Q_1$ is the series regulator and point $B$ the input to the error correcting loop. The desired or reference voltage is set in at $Q_3$. The error signal appears at point $B$ and is the voltage at point $A$ attenuated by the factor $R_2/(R_1 + R_2)$.

### New Approach

Some factors which tend to lower the loop gain of the error correcting amplifier are reduced by a special circuit[1]. In addition, it is possible to lower the output impedance of the regulated supply by feeding the unattenuated output error voltage directly into a differential amplifier which is operated from two gas tube regulated auxiliary supplies[2].

A design using a new principle to obtain an unattenuated error signal is shown in Fig 2. A constant current generator feeds resistor $R_1$. For a fixed value of $R_1$, there will exist a constant voltage across this resistor equal to $I_1R_1$. The resistor with its constant current may then be considered the equivalent of a battery. Therefore, any error voltage existing at point $A$ will be transferred, without attenuation, to point $B$, the input of the error-correcting amplifier. By making either $I_1$ or $R_1$ variable, the output voltage can be varied.

The ideal condition of constant current through $R_1$ is modified in practice by the finite current drawn by the base circuit of the input transistor of the error-correcting amplifier. The loading effect is

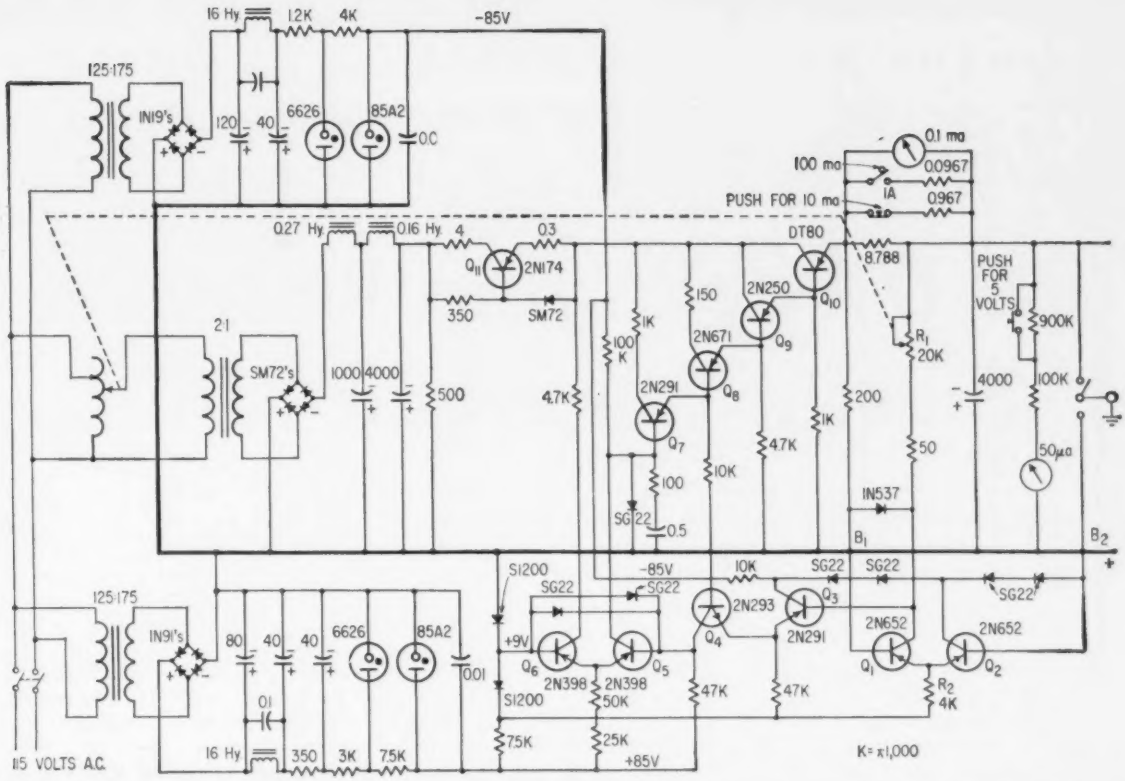


**FIG. 3.—Regulated power supply uses two gas tube regulated auxiliary supplies to obtain performance. With a load current of 900 ma, drift in 30 minutes is about 5 mv**

# Transistor Power Supply

minimized by keeping constant current $I_1$ much larger than the base current of the input transistor.

Constant current coupling as used in this power supply is not unusual in d-c amplifiers designed for neurophysiologic use[2]. The application of this circuit to a regulated power supply appears to be a new approach to the problem.

A transistor operated in the common-base configuration has a high output resistance and can be used satisfactorily as a constant-current source. In the practical operational circuit of Fig. 3, $Q_1$ is the constant-current source and $Q_2$ is used as thermal compensation for $Q_1$. Both $Q_1$ and $Q_2$ are fastened to a common heat sink to keep them at the same temperature.

The points $B_1$ and $B_2$ on the B+ bus must be kept close together physically. Otherwise, the IR drop along as little as ¼ in. of solid number 12 copper wire is enough to cause a rise in output voltage as the load current increases.

The use of auxiliary positive and negative supplies follows from reference 2. The 6626 regulator tube is used in preference to an OA2 since it has better constant-voltage characteristics. The supply shown at the lower left of the schematic uses S1200 thermally compensated Zener diodes to obtain a drift-free reference voltage.

### Performance

Regulation of the supply from zero load to 900 ma is 30 mv at 36 volts output. Ripple is less than 2.5 mv peak-to-peak. Line changes up to 10 percent do not affect the output.

Drift of the supply is less than 5 mv after 30 minutes operation at 750 ma. But temperature changes have a relatively large effect on drift. Without a one inch blanket of acoustic grade fiberglass over $Q_1$ through $Q_6$ transistors and circuits, drift was approximately 40 mv in 15 minutes. With the chassis removed from the cabinet and no thermal blanket, drift was 100 mv over a few minutes. Thus a 20 to one improvement in drift was obtained by relatively simple means.

The complete supply is shown in the photograph where it is being used to check an experimental circuit.


REFERENCES

(1) R. D. Middlebrook, Design of Transistor Regulated Power Supplies, *Proc IRE*, 45, p 1502, Nov. 1957.

(2) T. H. Brown and W. L. Stephenson, A Stabilized D-C Power Supply Using Transistors, *Electronic Engineering*, 30, p 425, Sept. 1957.

(3) J. Y. Lettvin, personal communication.

New technique achieves densities of 65 analog components and 160 digital components per cubic inch. Reliability and production rate also improved by modular construction process

# 3-D Packaging Reduces Size of Electronic Units

By ELDON C. HALL and RICHARD M. JANSSON,
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RESEARCH AND DEVELOPMENT in the field of air and space vehicle guidance systems is placing an ever-increasing premium on lightweight, miniature and reliable electronics. The electronic devices used must also be able to operate satisfactorily over a wide range of environmental conditions, particularly those of temperature, humidity, vibration and acceleration or shock. The electronic packaging technique to be described was developed to meet, more fully than in the past, these critical demands.

Referred to as 3-D or high-density electronic packaging, the new technique involves mounting and wiring circuit components in a miniature three-dimensional unit mass. By using miniature components now available from manufacturers and a newly-applied method of joining wire leads, 3-D packaging has achieved a maximum component density without sacrificing production feasibility.

The 3-D technique consists of placing circuit elements side by side and forming the electrical connections on a three-dimensional basis as opposed to the two-dimensional printed circuit board. The wires are joined by electrical resistance spot welding, which is similar to the vacuum tube technique. After assembly and electrical checkout, the unit is encapsulated in epoxy potting compounds to form a module. The resulting miniature package is a maximum-density assembly occupying all practical space within the package.

When applied to analog circuits, 3-D packaging has achieved component densities up to 65 components per cu in. Although these figures do not compare with densities achieved in microminiature binary-circuit techniques now under development, they have been obtained using such components as JETEC-cased transistors, transformers, microfarad capacitors and others not found in binary circuits. In digital circuits, densities of 3-D modules up to 160 components per cu in. have been obtained.

With a high component density, the completed module forms a unit mass that is nonresonant and structurally rigid—a desirable design feature for meeting conditions of shock and vibration that may be encountered under operating conditions for air and space vehicles.

### *Analog Circuits*

Distinct differences in approach have been found necessary for packaging digital computing circuits and analog servo circuits. In digital wiring, the large number of interconnecting logic wires complicates the design of the 3-D wiring setup and special layout techniques are necessary. In analog packaging, on the other hand, the chief problems encountered are heat dissipation from the module and interelement coupling effects of components in close proximity.

An example of analog wiring and component arrangement is shown in Fig. 1, which illustrates a resolver drive amplifier. Electrical designers must deal with the problem of interelement coupling in this type of 3-D module, a problem usually not found in the breadboard or printed circuit assembly. Types of circuits used in analog electronics are, in general, very broadband, high-gain amplifiers with generous feedback. A compact three-transistor amplifier, for example, if potted in a Mu-metal shielding can, may give rise to stray coupling through the can to the input. Circuit design and component arrangement, therefore, must be carefully planned to avoid combinations that would lead to any oscillatory instabilities.

After accomplishing the circuit design and component layout, taking into account the coupling problem and the most efficient packing arrangement, a production drawing is prepared in plan and elevation showing all views of the unit and the location and orientation of each component as well as the location of each weld. Components are numbered on the drawing for production identification. The wiring configuration is clearly outlined

FIG. 1—Resolver drive amplifier shows application of 3-D packaging technique to analog circuits

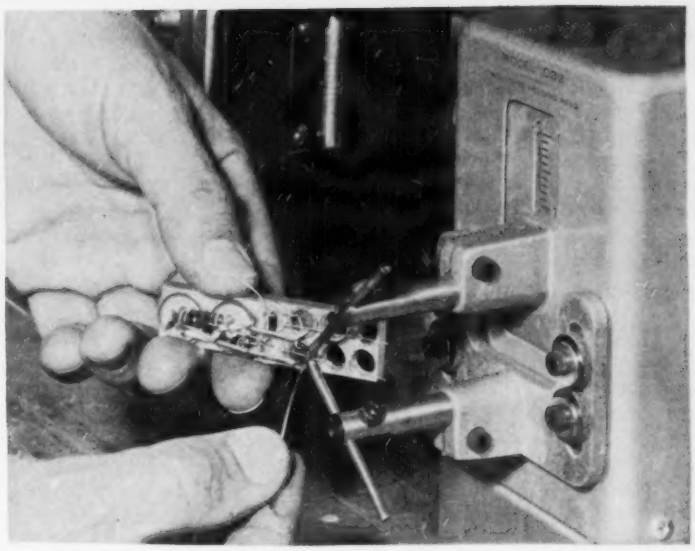


FIG. 2—Miniature welding head and special jig holds components during welding of wire leads

showing all connections. Terminal connection instructions are also included, along with color coding of the terminals.

A major problem in the assembly of analog circuits was the variety of weld types to be handled, since component leads span quite a range of sizes and materials. It was found that by using a flat, nickel ribbon as the common lead-joining medium, welding became more uniform and one weld setting could handle a number of weld types. A by-product of the use of this type wiring was an increase in structural rigidity of the unit before encapsulation. This is an important consideration since the unpotted assembly is held together only by leads, welds and small amounts of Mylar tape.

Handling must be kept to a minimum since damaging strains can result from excessively rough treatment. After potting, of course, the modules are quite rugged and are fully capable of meeting missile environmental specifications. Figure 2 shows a weld being made on a 3-D component, using a miniature welding head and a special jig to hold the components during welding.

As an illustration of the densities to be achieved, plans are in effect to provide for a package containing analog electronics with dimensions of 0.15 to 0.19 cu ft, weighing 15 to 20 pounds, in one unit mass structure. For this same system, a tightly designed electronics package using printed circuit boards had a volume of 0.6 cu ft and a weight of slightly less than 40 pounds.

### *Thermal Problems*

Thermal conditions within modules must be seriously studied. If power levels are reasonably low, as in the case of digital computer circuits, the modules can be stacked into one block and tied together, with the thermal problem treated rather lightly. For example, aluminum foil can be placed between layers to conduct the dissipated heat to an appropriate heat sink. However, analog circuits contain elements that require more heat sinking than corresponding elements of digital circuits. To accomplish the necessary heat transfer in the case of individual signal-level transistors, the transistor can be wrapped in aluminum foil which, in turn, is attached to an aluminum plate on one face of the module. A layer of such modules can be clamped to each side of a cold plate, thereby removing the heat from each module.

In addition to signal-level modules, power transistors potted into modules with the copper heat transfer face exposed (without studs) can also be effectively handled by this method of clamping to a cold plate. The result is a greatly simplified (and cheaper) cold plate design; and there are no mounting studs to interrupt the heat-transfer fluid passages. This design feature alone effects a considerable reduction in the volume required for heat exchanger equipment.

To determine the values, and the distribution of values, of the thermal resistance between encapsulated power transistors and the surface of a cold plate, tests were made with representative modules mounted on a heat exchanger. An average value of the mounting thermal resistance for H-10 transistors, based on 64 test points, was determined to be 0.38 C/w with maximum and minimum values of 0.49 C/w and 0.26 C/w, respectively. For H-7 transistors, the thermal resistance is higher due to the smaller contact area, and results of the test gave an average (based on 56 points) of 0.84 C/w. Maximum and minimum values of the thermal resistance in this case were 1.00 C/w and 0.74 C/w.

### *Digital Circuits*

The digital circuits described are used in an inertial guidance digital computer. In this type of computer, the thermal problem is not as critical in the design of 3-D packages. On the other hand, however, the large number of interconnecting

wires and the importance of correct logic wiring has made it necessary to develop special techniques in applying the design to the 3-D package.

It may be seen, from a brief explanation of the type of data-handling circuits used in the computer, that the logic wiring has been made the controlling member in the computer design.

The computer is made up of three basic elements: NOR gates, a shift-register memory, and a crystal-controlled clock. The interconnecting wiring between these three elements provides the logical function of the computer.

The NOR gate is the only type of circuit building block used in the logic, the memory read-in and the memory read-out circuits. Each memory read-out consists of two NOR gates connected to provide a set-reset flip flop, resistor-coupled to the memory. The memory read-in circuit consists of an OR block, which is the same standard NOR gate circuit with the collector load resistor removed. The installation of the resistor between the flip flop and the memory and the removal of the collector load resistor in establishing the OR block are both part of the production process when the logic wiring is applied.

The circuit shown in Fig. 3 is an example of the data-handling arrangement. An explanation of the NOR and OR symbols is also shown. Because of the exclusive use of identical NOR gates, a series of identical circuits can be used in 3-D packages and interconnected as needed in the design throughout the computer.

The computer is designed around the shift-register memory (also called a memory stick), which also contains repetitive circuit features whereby a standardized form of component layout can be employed in the 3-D module. The clock is the only element containing nonrepetitive circuits. Therefore, the design of the computer is established by controlling the pattern of the logic wiring.

The resulting 3-D package can be constructed in the form of a stick. This form of module can easily be assembled into a cube or other shape to provide for a multiple-stick assembly. Figure 4 shows such an assembly together with the various stages of assembly of a logic stick containing 36 transistors, 144 diodes, 36 capacitors and 108 resistors. The stick is 7.5 in. long.

### *Logic Stick Construction*

To position the multitude of parts in the stick and to hold them together during welding, a technique of film jigging was developed. This technique employs two punched insulating films of Mylar tape to ac-

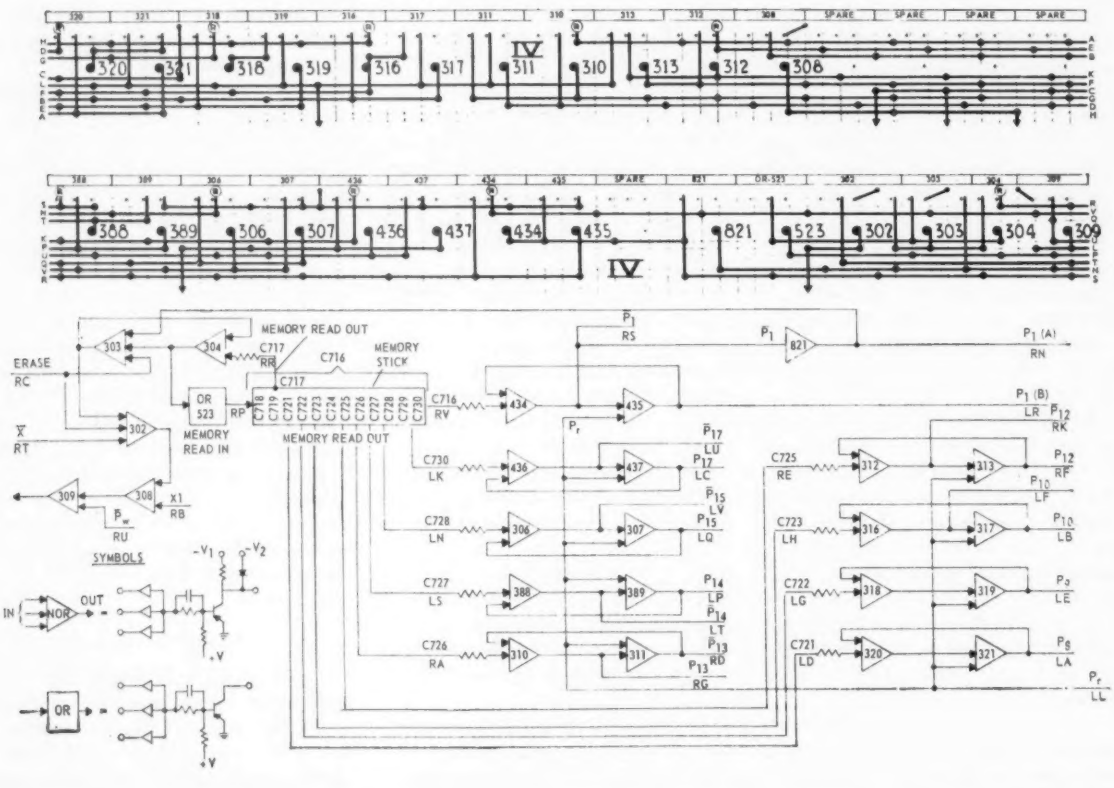



FIG. 3—Logic matrices (top) show film instructions for circuit diagram at bottom

curately position all component leads. The film becomes a permanent part of the assembly, also acting as a physical insulating barrier between the stick components and the power buses and/or logic wiring incorporated on them.

The original layout of the stick is reflected in the instructions on the film, thus providing the information for proper positioning of the components. The film jig information is based on the original component layout drawings, which indicate all component positions, lead locations, and power bus interconnections in plan and section. From these drawings, overlay drawings are made showing the location of each lead in the plane of the film jig. This layout is photographically reduced to the jig size and produced on the Mylar tape.

The lead locations are punched on a power punch to provide the properly oriented holes through which the lead wires are to protrude when the components are inserted. In the design and layout of sticks, the film jigging procedure eases the design process and ultimately results in the transfer of information to the fabricator in an expeditious manner.

The logic wiring matrix that is applied to each side of the stick is manufactured separately from a wire mesh structure mounted in a frame. Mylar tape, with instructions for the welder, is also used in this operation to separate and hold the wires. Logic film layouts are prepared, as in the component layout, and tack-weld points, clip areas, switch number, bus identification and subassembly identification are all included on the film. The logic film is slipped between the longitudinal and cross-bus layers of the wire mesh and all welds are then made. Weld points are indicated by a hole punched in the tape. The welded matrix is clipped from the metal jig and the subassembly is hand-clipped and tested for conformance to the layout.

As a further comparison with the printed circuit board technique, a 3-D digital computer electronic package now being designed will have a total volume of 0.1 cu ft and weigh under 10 pounds, whereas the volume of a tightly designed printed

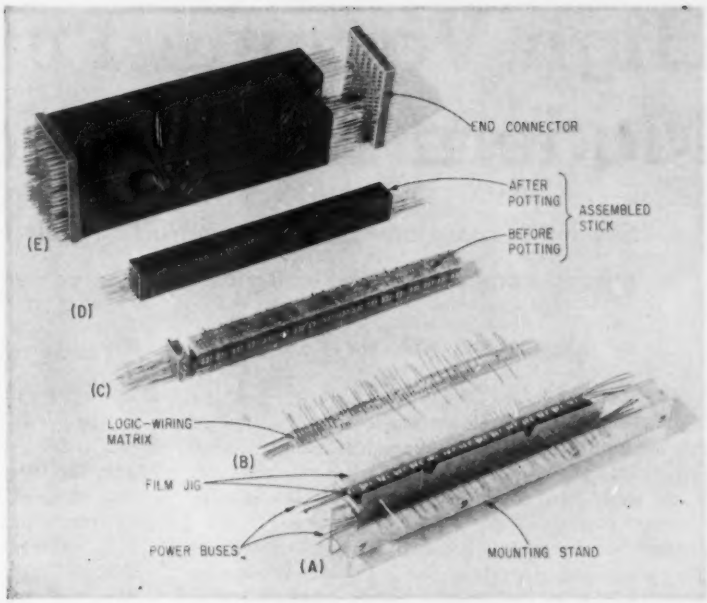



**FIG. 4—Film jig holds components in place (A); logic wiring matrix (B) is then welded on, resulting in assembled stick (C and D). Multiple-stick assembly (E) requires end connector to connect logic wiring between sticks in accordance with logical design of computer**

circuit computer package, assembled for the same system, is 0.4 cu ft with a weight of approximately 26 pounds.

### *Other Advantages*

Some marked advantages over other methods have emerged from experiments in producing and testing these 3-D units. One significant feature is the fact that present welding facilities for vacuum tube manufacturing are ideally suited, and the manufacturers are therefore presently equipped, for the production of 3-D modules.

It has also been shown on a developmental basis that this welding technique greatly reduces the assembly time as compared with manual assembly of printed circuit boards. For example, it is estimated that two technicians can assemble a 3-D package in the same time it takes six technicians to assemble the same circuit using two-dimensional printed circuit boards.

Design flexibility is another important feature because of the variety of components that can be handled and the manner in which they can be used. Transistor circuitry from signal level to power level when packaged by this method lends itself to easier solution of heat transfer, mounting accessibility and package design problems. This is because the shape of the module can be molded to suit particular needs and module groups can be arranged to fit unique package configurations. As for reliability, a vacuum tube manufacturer has estimated on the basis of vacuum tube production experience that for an assembly using 3-D packaging and containing several hundred welds, only one in 10,000 assemblies will be rejected because of bad welds.

The 3-D packaging program described herein is being carried out under the joint sponsorship of the Ballistic Missile Division, U. S. Air Force and the Bureau of Ordnance, Department of the Navy. Acknowledgment is also due Samuel Francis of Francis Associates, Marion, Mass. for the original concept on which the M.I.T. Instrumentation Laboratory's development work is based; Raytheon Manufacturing Company and Sippican Corp. for their manufacturing and engineering help, under subcontract to M.I.T.; and William H. Mann of Jackson & Moreland, Inc. for assistance with this presentation.

FIG. 3—Logic matrices (top) show film instructions for circuit diagram at bottom



# High Vacuum Pumping for Modern Electronic Needs

## Simulating space environments, constructing molecular electronic circuits, degassing components and materials are chores for high-performance pumps

By **NORMAN BEECHER,** Project Manager, National Research Corp., Cambridge, Mass.

RADIO TUBES were one of the earliest applications of high vacuum. The diffusion pump, developed by Langmuir, is still the workhorse of the high vacuum field. Today, many new electronic techniques also require vacuum systems.

Semiconductor thin films are formed by vacuum evaporation and deposition at very low pressures. Vacuum degassing and drying prepares dielectric oils. Oil impregnation in vacuum chambers eliminates trapped moisture and gas bubbles.

The space age requires new specifications for electronic equipment operating in satellites and rockets. Vacuum testing to detect vibration failure, overheating or evaporation of materials is essential. Chambers large enough to house satellites have been built. They must be pumped down rapidly and maintain high vacuum despite the release of large amounts of absorbed gases from the components tested.

**FOREPUMPS**—High vacuum pumps attain pressures of $10^{-3}$ mm Hg or below. Ordinary mechanical vacuum pumps sealed with oil will produce $10^{-2}$ mm Hg with fairly low pumping speeds. Simple rotary types handle permanent gases satisfactorily. Rotary gas ballast types handle condensable gases like water vapor. Air is admitted with the pumped gas, diluting the gas so that it will not condense in the pump. This prevents addition of condensed water to the pump oil.

Rotary pumps are generally used as the forepump backing up a high vacuum pump. All diffusion pumps and molecular drag pumps constructed to date require a forepump. Ion-gettering pumps need a forepump for startup and initial pumpdown, but have the advantage of consuming gases rather than discharging them.

**PUMP SELECTION**—Oil diffusion pumps are the most economical. If the vacuum system cannot tolerate even a trace of oil vapor, it may be feasible to use mercury diffusion pumps. The latter is used, for example, in evacuating fluorescent lamps where mercury vapor is already present.

Where the pressure on the high vacuum side is as high as 0.1 mm Hg, the use of the ejector principle with oil or mercury is advantageous. Ordinary diffusion pumps begin to lose efficiency above $10^{-3}$ mm Hg. The booster type oil diffusion pumps cover the range between ejectors and regular diffusion pumps.

For high capacity pumping between 10 and 0.001 mm Hg, Roots blowers with a mechanical forepump can be used. The Roots blower pumps with a pair of interlocking metal impellers. For pressures below $5 \times 10^{-7}$ mm Hg, it is usually desirable to use a cold trap with diffusion pumps to minimize escape of pumping fluid into the vacuum system. Such traps generally have a liquid nitrogen-cooled surface blocking line-of-sight passage between pump and vacuum chamber.

Ion-gettering pumps are especially useful for cyclotrons where low helium pressure is permissible, but all air in-leakage should be removed. They can pump for long periods in a sealed system.

Molecular drag pumps are not used much in this country, but provide satisfactory clean systems for experimental work. The Pfeiffer pump should be commercially available soon and the Beaudoin pump has been on the market for some time. These pumps, however, operate at high speed and are expensive.

Cryogenic pumps, using very cold surfaces to condense certain gases, have long been used and are highly efficient for condensable gases. Temperatures in the range from liquid nitrogen to helium are used. It is usually desirable to design the cryogenic pump for a specific system (NRC and Arthur D. Little, Inc., have experience in this field).

The list of pumps in Table I is not exhaustive and omission of a pump or manufacturer does not imply an unfavorable judgment. Only the largest pump in a line is described. These are generally large enough for test chambers. Smaller pumps will handle such pumping work as tube evacuation. Construction material is metal, except that EIM and NRC-G-2-M employ glass.

### KEY TO MANUFACTURERS

| | |
|---|---|
| **BEA** | Beaudouin (French, available through NRC) |
| **CEC** | Consolidated Electrodynamics Corp. |
| **EIM** | Eitel-McCullough, Inc. |
| **KIN** | Kinney Manufacturing Co. |
| **LEY** | Leybold (German, available through NRC) |
| **NRC** | NRC Equipment Corp. |
| **PFE** | Pfeiffer (Germany) |
| **STO** | F. J. Stokes Corp. |
| **VAR** | Varian Associates |
| **VEE** | Veeco Vacuum Corp. |

have a total volume of 0.1 cu ft and weigh under 10 pounds, whereas the volume of a tightly designed printed

handled and the manner in which they can be used. Transistor circuitry from signal level to power

M.I.T.; and William H. Mann of Jackson & Moreland, Inc. for assistance with this presentation.



**Table I—Characteristics of Representative Commercial High Vacuum Pumps**

| Mfgr and Model | Dimensions (inches) | Optimum Range (mm Hg) | Max Pump Speed, Air (liters/sec) | Discharge Pressure (mm Hg) | Heater Power (kw) | Cooling Water (gpm) | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|---|
| **FRACTIONATING OIL DIFFUSION, 3-STAGE** | | | | | | | | |
| NRC H-32-P[a] | 60 high 32 i.d. | $5\times10^{-7}$ $-1\times10^{-3}$ | 30,000 @ $4\times10^{-5}$ (b) | 0.2 | 9.5 | 4 @ 20 C | no controls, no moving parts, pumps all gases, inexpensive, oil has low vapor pressure eliminating need for cold traps | oil vapor may contaminate vacuum system, forepump required |
| CEC MCF 15000A[a] | 80 high 32 i.d. | $5\times10^{-7}$ $-1\times10^{-3}$ | 27,500 @ $1\times10^{-4}$ (b) | 0.07 | 7 | 2 @ 20 C | | |
| STO 16″ Ring Jet[a] | 54 high 16 i.d. | $5\times10^{-6}$ $-1\times10^{-2}$ | 5,000 @ $1\times10^{-3}$ (b) | 0.1 | 5 | 2 @ 20 C | | |
| KIN VF-1600[a] | 31 high 16 i.d. | $5\times10^{-7}$ $-1\times10^{-3}$ | 5,200 @ $2\times10^{-4}$ (b) | 0.2 | 5 | 1 @ 20 C | | |
| LEY DO-4001[a] | 27 high 14 i.d. | $5\times10^{-7}$ $-2\times10^{-3}$ | 4,000 @ $1\times10^{-6}$ (b) | 0.2 | 3 | 0.3 @ 20 C | | |
| VEE[a] EP-4W | 15 high 4 i.d. | $5\times10^{-5}$ $-2\times10^{-2}$ | 400 @ $5\times10^{-3}$ (b) | 0.5 | 0.5 | 0.5 @ 20 C | | |
| EIM | 16 high 4 i.d. | $5\times10^{-7}$ $-1\times10^{-4}$ | 67 @ $1\times10^{-5}$ (b) | 0.001 | 0.2 | (air cooled) | | |
| **BOOSTER TYPE OIL DIFFUSION, 2-STAGE** | | | | | | | | |
| NRC B-12[a] | 49 high 12 i.d. | $5\times10^{-4}$ $-5\times10^{-2}$ | 2,800 @ $1\times10^{-3}$ (c) | 0.8 | 14 | 4 @ 20 C | same as above, designed for higher pressure range, large mass capacity | same as above |
| STO 16″ Ring Jet | 92 high 16 i.d. | $5\times10^{-4}$ $-1\times10^{-1}$ | 3,500 @ $1\times10^{-2}$ (c) | 1.5 | 36 | 5 @ 20 C | | |
| LEY OT8000 | 47 high 20 i.d. | $5\times10^{-4}$ $-1\times10^{-2}$ | 6,000 @ $1\times10^{-3}$ (c) | 0.3 | 5.7 | 4 @ 20 C | | |
| **OIL EJECTOR (OE) AND OIL DIFFUSION-EJECTOR (ODE)** | | | | | | | | |
| CEC (OE) KJ-5000[a] | 140 high 70 long | $2\times10^{-3}$ $-1\times10^{-1}$ | 5,500 @ $9\times10^{-2}$ (c) | 3.2 | 23 | 4 @ 20 C | same as above; quieter than Roots blower, no damage from dirt | same as above; bulkier, narrower pressure range than Roots blower; oil traps dirt, must be periodically changed |
| LEY (OE) ODP-300[a] | 60 high 80 long | $3\times10^{-3}$ $-5\times10^{-1}$ | 300 @ $1\times10^{-1}$ (c) | 3 | 9 | 4 @ 20 C | | |
| CEC (ODE) KS-16000[a] | 111 high 156 long | $3\times10^{-4}$ $-6\times10^{-3}$ | 19,200 @ $2\times10^{-3}$ (c) | 2 | 19 | 33 @ 20 C | | |
| **MERCURY DIFFUSION (MD) AND MERCURY EJECTOR-DIFFUSION (MED)** | | | | | | | | |
| CEC (MD) MHG-900[a] | 29 high 10 i.d. | $1\times10^{-6}$ $-2\times10^{-4}$[d] | 1,600 @ $5\times10^{-5}$ (b) | 0.26 | 2 | 0.3 @ 5 C | same as oil diffusion, Hg contaminant sometimes more tolerable than oil like MD except max speed at $10^{-1}$ to $10^{-2}$ | Hg poisonous, Hg contamination in case of trap failure very substantial; cold trap needed below $10^{-3}$ mm; forepump needed |
| NRC (MD) G-2-M | 20 high 3 i.d. | $5\times10^{-6}$ $-5\times10^{-2}$[d] | 55 @ $1\times10^{-5}$ (b) | 0.5 | 0.3 | 1 @ 25 C | | |
| LEY (MED) Hg 45 | 33 high — | $1\times10^{-6}$ $-5\times10^{-1}$[d] | 45 @ $1\times10^{-1}$ (b) | 20 | 2.4 | 1 @ 25 C | | |
| **ION-GETTERING** | | | | | | | | |
| CEC EI-2000 | 25×22 pump[e] | $1\times10^{-7}$ $-1\times10^{-4}$ | 1,900 @ $2\times10^{-6}$ (f) | (g) | (h) | | little contamination, sealed, forepump only for startup | getter feeding mechanism may break down[i] |
| VAR Vac-Ion | 35×10 pump[e] | $1\times10^{-6}$ $-1\times10^{-4}$ | 280 @ $10^{-6}$ $-10^{-7}$ (j) | (g) | (k) | | no contamination, no moving parts, selfmeasuring | high cost for amount of pumping[i] |
| **MOLECULAR DRAG** | | | | | | | | |
| BEA | 15 high 15 long | $1\times10^{-6}$ $-1\times10^{-3}$ | 60 @ $10^{-3}$ $-10^{-4}$ (l) | 2 | (1/9 hp motor) | | no contamination, no seals (motor in vacuum) | 7,000 rpm, 0.002 clearances, dirt damage |
| PFE | 15 high 20 long | $1\times10^{-6}$ $-1\times10^{-3}$ | 140 @ $10^{-3}$ $-10^{-4}$ (l) | 0.004 | (1/4 hp motor) | | good design for high capacity, elimination of seal leakage | 16,000 rpm but fairly wide clearances, bearing seal problems |

(a) Manufacturer has line of pumps with similar characteristics (b) Other gases: pumping speed increases with decreasing molecular weight, $H_2$ pumped at approximately twice air rate (c) Like (b) but not as much as 3-stage pumps (d) Pressure of permanent gases only; Hg has vapor pressure of $2\times10^{-3}$ at 25 C, can be eliminated with cold trap (e) Controls add 25×42 and 22×12 inches, respectively (f) Pumps noble gases about 1 percent air speed, methane poorly (g) Gas is consumed, not discharged; pump down to 0.015 mm required for startup (h) Variable to 2 kw for heater, small motor, controls (i) Also, complex controls and power supply (j) Pumps noble gases about 10 percent air speed (k) Variable to 1 kw for controls, electron emission (l) Light gases slightly faster

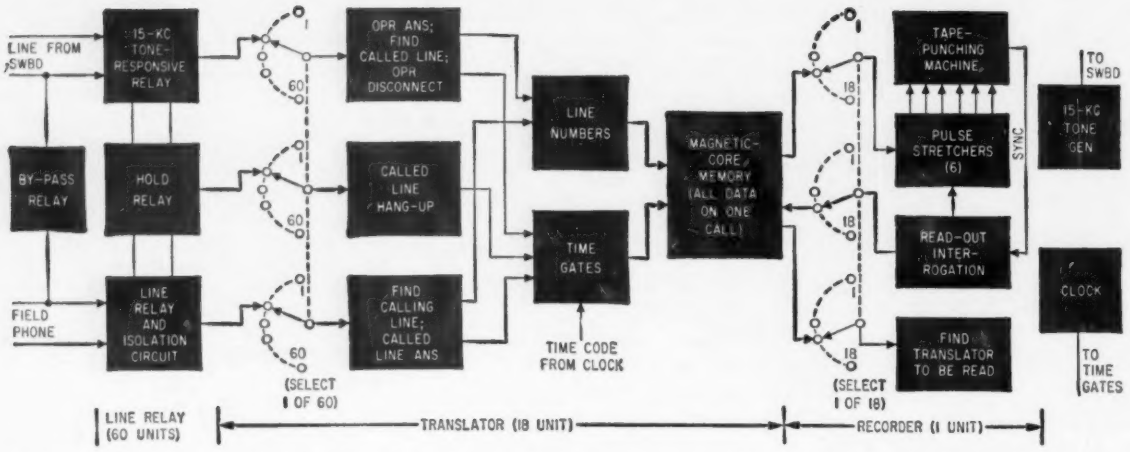



**FIG. 1—Functional diagram of traffic recorder system shows method of obtaining information on each call and call attempt**

# Ferrite Memories Simplify

**In typical telephone traffic data recorder systems, data reduction is necessary before all information on one particular call is obtained. This recorder allows information on individual calls to be recorded as one entry**

**By J. W. BLANCHARD, E. C. BELLEE and J. SMITH,** University of Arizona, Tucson, Arizona

COMPLETE ANALYSIS of telephone traffic in a communications system requires a permanent record of all action occurring at each telephone switchboard. The records obtained at the switchboards can be reduced, at a central location, by means of a high-speed digital computer. The result of this process of telephone traffic data collection will be a complete tabulation of all calls.

Figure 1 is the functional diagram of a traffic recorder system designed to work with a switchboard that has provisions for 60 telephone lines and patch cords that allow 15 calls to be in process at any time.

Each of the 60 telephone lines has a line-relay unit that senses signals and, depending on the sequence of the signals, provides logic signals to control the translator unit.

To record data on the 15 calls that may be in progress at one time and to record call attempts during an all circuits busy condition, 18 translation units are used. Each translator has access to all 60 line-relay units. A temporary memory in each translator allows it to record all data on any complete telephone conversation or call attempt, thereby grouping the data for later ease of analysis. When all necessary data have been collected on any call, the contents of the memory are transferred, in a group, to the recorder unit. Here the data are permanently stored on punched paper tape for later collection and analysis at the data analysis center.

Auxiliary equipment consists of a clock unit that provides real time signals in the form of 6-digit binary signals, a 15-kc tone generator that provides a carrier signal to the switchboard, permitting recognition of operator functions, and a power supply that provides input power of 50 v for operation of the relay and transistor circuits.

The clock shown in Fig. 2 provides real time signals in six-digit binary code to all translator units. It consists of 17 cascaded binary counters with feedback around the seconds and minutes sections to reset after 60 counts and feedback around the hours section to reset after 24 counts.

In contrast to the usual electronic binary counters this unit consists of relay binary counters.

Using a zero-impedance source, as provided by relay contacts, for the binary time signals to the translators eliminates the need for individual buffer matrix drive units in each translator. This provides a considerable reduction in equipment size and complexity.

### *Translator*

The translator provides the line search mechanism by which the calling line and called line are found and identified. This function is performed in conjunction with command signals from the line relay units. A signal from the calling line-relay unit activates the line-search circuit, allowing a stepping switch to run self interrupted until the line is found.

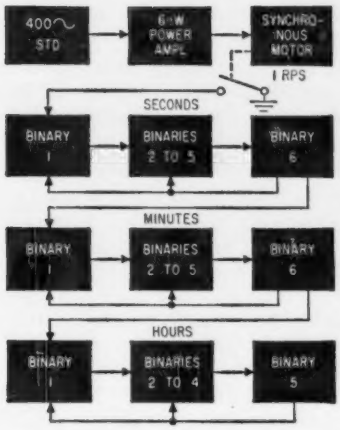
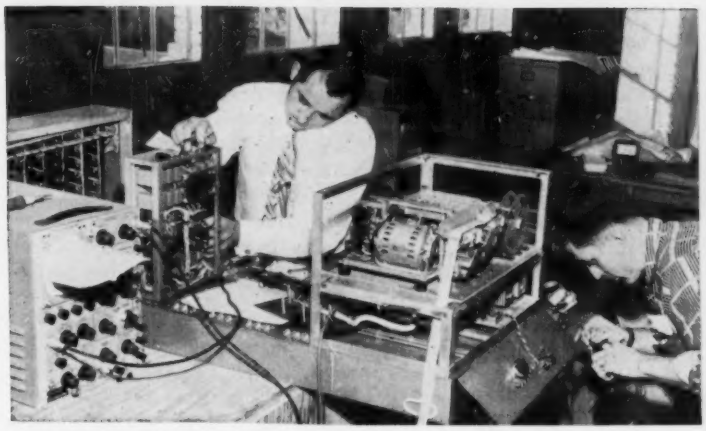



FIG. 2—Binary clock uses relays and feedback to obtain real time signals



Two of the authors checking pulse sensing and stretching networks by manually interrogating ferrite core memory

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When the called line-relay unit receives a 15-kc signal it reactivates the search circuit allowing the same stepping switch to find the line-relay unit associated with the called line. A binary code corresponding to the number of each telephone line is produced by the stepping switch.

The translator also provides the necessary switching logic and ground gates that allow the real time signals on the clock output to be recorded in the temporary storage unit whenever the proper sequence of events occur. For example, when a call is placed, the time and line identification are read into storage after the calling line has been found. When the operator answers the calling party, a signal from the line-relay unit to the translator triggers the switching necessary for recording the time of occurrence of this operation.

Upon completion of the call, the magnetic memory is full, and an associated relay circuit signals the recorder unit that it is ready for

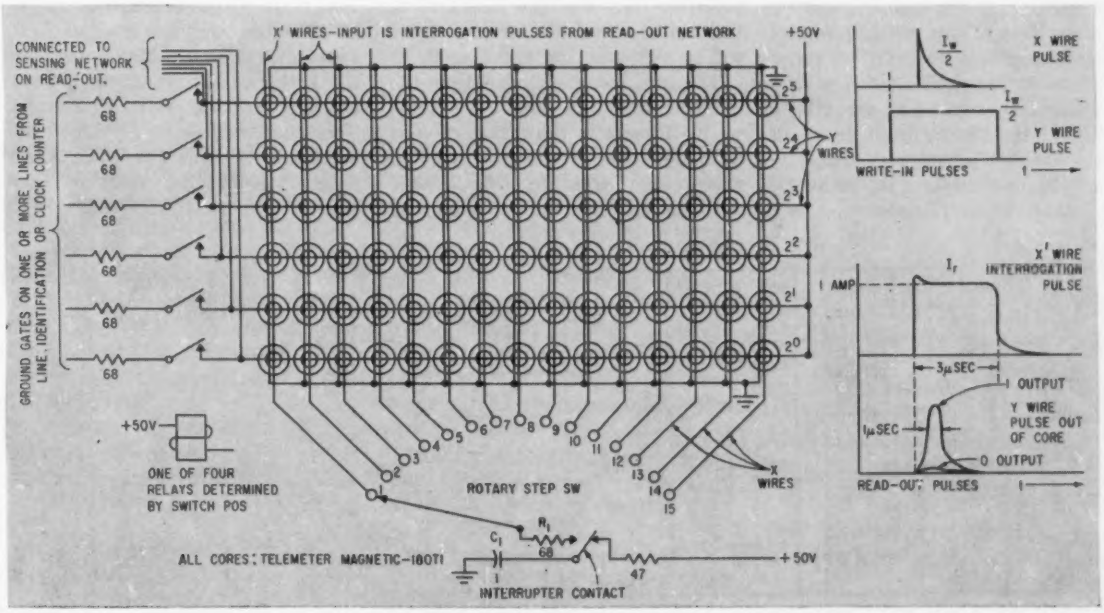
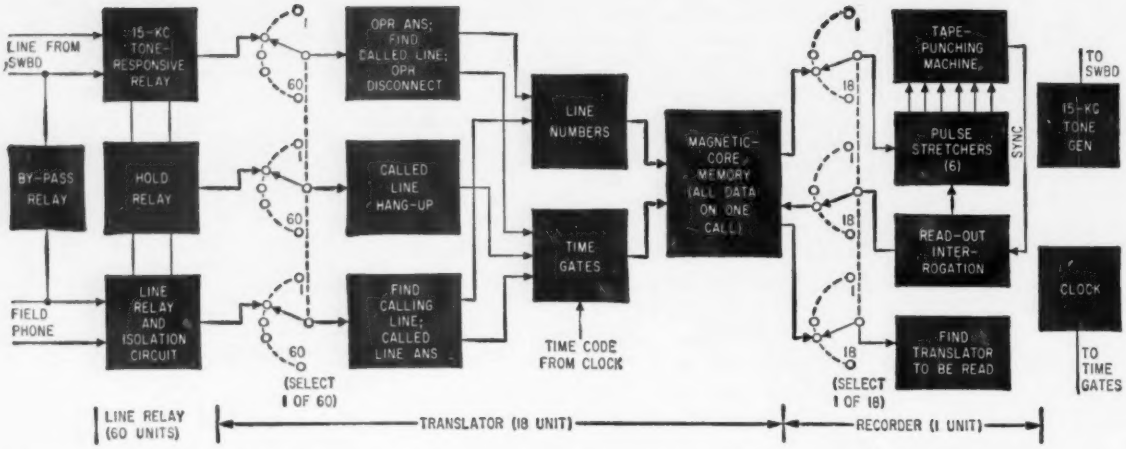



FIG. 3—Matrix circuit uses rotary step switch to provide time signals and line identification at output. Read-out and write-in pulses are shown

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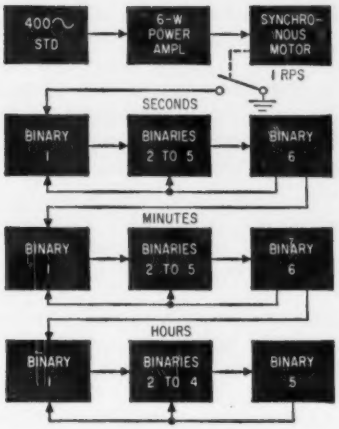


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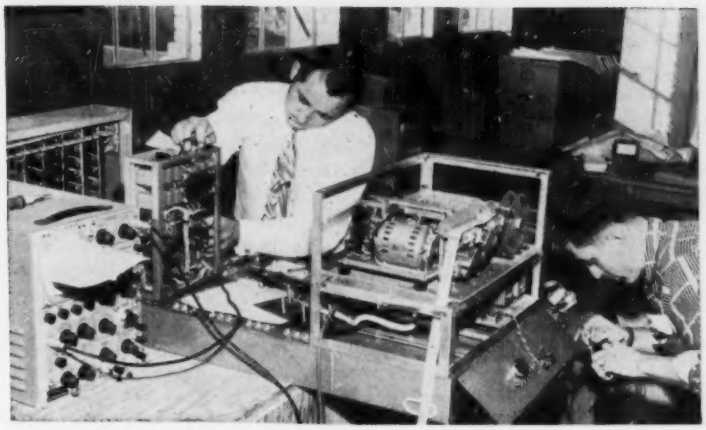

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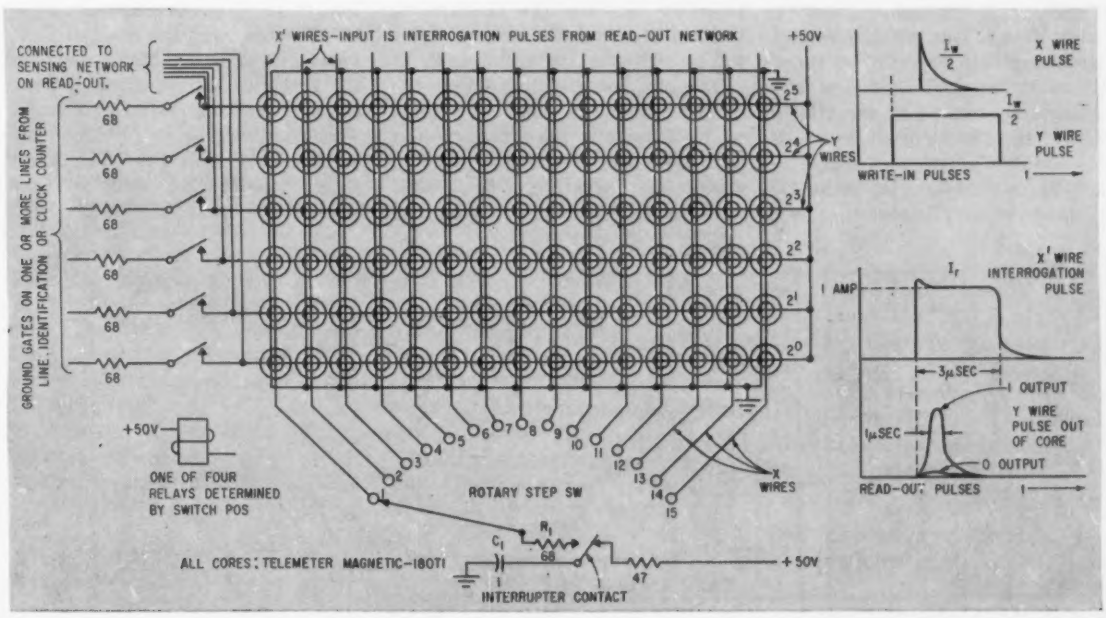



FIG. 3—Matrix circuit uses rotary step switch to provide time signals and line identification at output. Read-out and write-in pulses are shown

readout. In the case of busy lines or any other unusual call situations, a gate causes the memory to be completed, making it ready for readout. In these cases the time recorded in the memory will be the same for each storage position beyond the last position in which the call sequence was normal. This feature permits the identification of the different unusual call situations.

### Memory

The use of a temporary memory in each translator virtually eliminates data reduction. The temporary memory allows association of a memory matrix with each individual phone call from the time of its origination to the time of its completion. At the time the call is completed the data is transferred, as one entry, into the paper tape permanent storage section of the recorder unit. Data from the permanent storage unit is converted directly to card form for processing on a computer.

The matrix stores the data on a call in the form of 15 six-bit binary numbers, two numbers identifying the two lines involved in the call and the other thirteen giving the times that various events occur.

Figure 3 shows the write-in circuit and the write-in and read-out pulse waveforms. Depending upon the position of the stepping switch the low side of the matrix is connected to either one of the three sections of the clock or to the line identification section of the translator. If the switch is on position ONE, a relay is activated which connects the $Y$-write lines to the hours section of the clock counter.

The clock counter will supply ground gates corresponding to the time. If the hour is ten, a ground will appear on the $2^1$ and $2^3$ $Y$-write wires and these two matrix columns will receive half-write current pulses. The second and fourth cores in the first row are selected by a half-write current pulse supplied by $C_1$ discharging through $R_1$, the interrupter contact and the first $X$-write wire.

Both the $X$ and the $Y$ wires are single turn windings, while the $X'$ windings, which are the interrogation windings, have five turns. One of the relays on the low side of the matrix connects the $Y$ windings to the sensing circuit when the translator is selected by the recorder unit for the readout operation. The $Y$ wires serve as both write-in wires and sensing wires in the readout operation.

The interrogation pulse for the readout is a 1-amp, 3-$\mu$sec pulse that is provided by a blocking oscillator. Figure 4 is a schematic of the readout network that senses the output of the matrix. There are six of these circuits, one for each $Y$ wire. The input to this network contains a transistor coincidence circuit, $Q_1$ and $Q_2$. This coincidence circuit is necessary for reliable sensing because of the physical distance between the matrix and the recorder unit and the presence of the noise generated by the many rotary switches and relay used.

The interrogation pulse from the blocking oscillator which is applied to the $X'$ wire in the matrix is also applied to $Q_1$. If the core selected was in the ONE state, a 6-v, 1-$\mu$sec pulse appears on the secondary of pulse transformer $T_1$ and at the base of $Q_2$. This establishes coincidence, and a 1-$\mu$sec, 25-v negative pulse is applied to the input of the pulse stretching multivibrator $Q_3$ and $Q_4$. The output of the multivibrator is a positive 25-v, 20 millisecond pulse which turns on $Q_5$.

Relay $K_1$ is activated when $Q_5$ is switched on. A contact of $K_1$ completes the circuit through a punch magnet $K_2$ on a Friden tape punch. This punch magnet corresponds to the particular matrix column. The punch permanently records the fact that the selected core was in the ONE state by punching a hole in the paper tape.

### Typical Record

Figure 5 shows a typical punched tape record for one phone call. The record shows that line 21 placed a call 5 seconds after 11:40 and the operator answered 15 seconds later. Then at 11:40 + 25 seconds, the operator rang line 1. Line 1 answered at 11:40 + 51 seconds, the conversation lasted until 11:42 + 2 seconds and the circuit was cleared at 11:42 + 21 seconds.

Figure 5 also shows the information recording sequence; starting with time of calling line appearance and ending with operator disconnect.

The authors wish to acknowledge that much of the original design of this recorder was the work of G. R. Peterson and G. M. Russell of the Electrical Engineering Department of the University of Arizona. This equipment was developed under contract with the U.S. Army Electronic Proving Ground, Contract DA-36-039-SC-80012.

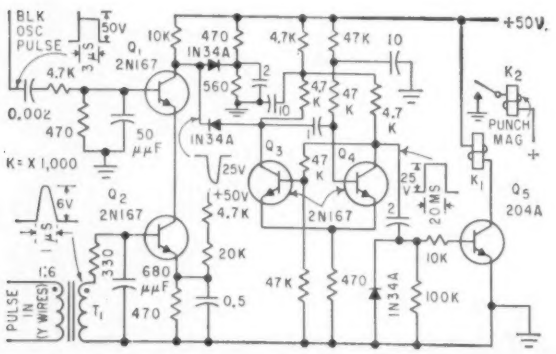



FIG. 4—Readout network uses coincidence circuit to insure reliable sensing

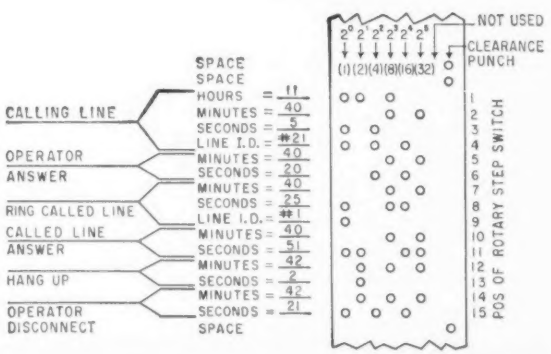



FIG. 5—Tape record shows how recording sequence is determined by rotary step switch in matrix circuit

# Using Feedback in Electrometer Design

**Here are the factors involved in designing a highly sensitive, wide-bandwidth, electrometer. Analysis shows how feedback circuits get desired results**

By **D. ALLENDEN,** Electronics Section Leader, Associated Electrical Industries Ltd., Aldermaston, Berkshire, England

THE INSTRUMENT to be described measures currents in the range of $10^{-11}$ amp to $10^{-15}$ amp. Measuring technique used is to pass a current through a high-value precision resistor and amplify the voltage across the resistor with the direct-coupled amplifier of an electrometer. Two problems inherent to this method are bandwidth reduction by the distributed capacitance across the resistor and the high input-impedance requirement of the d-c amplifier, which must not draw appreciable current. Another problem is drift in the d-c amplifier.

### *Drift*

Drift resulting from changes of supply voltages and tube characteristics is so large that drift less than $\approx$ 1 mv/hr, referred to the input, is hard to achieve.[1, 2] Very low drift requires a carier-frequency amplifier and at high impedance levels only the expensive vibrating-capacitor electrometer is available.[3, 4]

With a current-measuring electrometer the effect of drift is decreased by developing 100 mv or more across the measuring resistor. Thus, a direct-coupled amplifier with 1-mv drift is adequate for the electrometer unless very long-term stability, or a current sensitivity > $10^{-14}$ amp fsd (full-scale deflection) are required; current sensitivity is a factor because resistor stability and reliability fall off above $10^{12}$ to $10^{13}$ ohms.

Cathode variations in the first electrometer tube are the main cause of drift. However, if the stage gain is not very different from one, such variations in the second stage are equally significant. Balanced stages have been widely employed to reduce drift but have the disadvantage of increasing tube noise and uncorrelated drift by a factor of $\sqrt{2}$. As short-term cathodic variations are largely uncorrelated,[5] this electrometer uses single-ended rather than balanced stages.[6, 7]

Filamentary electrometer tubes are particularly suited to this application, since their low filament current permits efficient and economical stabilization, and as they give a high gain (above 50), second-stage drift is hardly significant. Voltage-dependent cathode drift is somewhat greater than 10 mv per 1-percent voltage change.

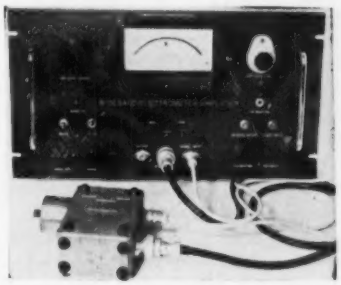
### *Electrometer Feedback*

Electrometer bandwidth is essentially determined by the high-impedance input circuit (Fig. 1A). Current-measuring resistor $R$ has its own stray shunt capacitance $C$. The steady state output voltage is $-AiR$ and the rise time-constant and bandwidth are, respectively, $R(C+C_o)$ and $1/2\pi R(C+C_o)$. Inserting typical values, ($R = 10^{12}$ ohms, $C \approx 1\mu\mu f$, $C_o = 5\mu\mu f$) gives an input time constant of 6 sec and a bandwidth of 0.025 cps.

Sensitivity of a simple electrometer of this type is normally varied by switching the input resistor.

This requires a special high insulation switch and accurate input resistors.

Figure 1B shows the system with



**Electrometer stage $V_1$ is inside a separate 5 × 3 × 2 in. screening box**

feedback added. Here, feedback-factor $\beta$ is frequency-independent. In this case, the steady state output (subject to the normal feedback-system criterion that $A\beta >> 1$) is $V_o = (-iR/\beta)$. Thus, the sensitivity can be changed by variation of $\beta$, eliminating the special switch, and range factors are established at low impedance levels in the feedback circuit where accurate resistors are reliable and inexpensive. Voltage gain is reduced, but large voltage gain is seldom required for electrometer application.

Effective input impedance is now $R/A\beta$, shunted by capacitors $CA\beta$ and $C_o$. The steady state resistance is much lowered, and, as $|A|$ varies arbitrarily, is not precisely defined; this is unimportant. The input time-constant is

$$(R/A\beta)(CA\beta + C_o) = R\,(C + C_o/A\beta)$$

Thus loop gain reduces the effect of $C_o$, but leaves the $RC$ term unchanged. In the previous example an infinite loop gain would increase the bandwidth by a factor of only

6, and a loop gain of 10 would increase it almost as much.

Inclusion of an integrating network ($\gamma$) in the feedback path (Fig. 1C) giving a $\beta$-transfer function of $\beta_0/(1 + p\tau)$ modifies the effects of input capacitance more significantly.[5] If $\tau = CR$, then $C$ is eliminated and the input impedance becomes $R/A\beta_0$ paralleled by $C_0$. The bandwidth can now be increased to any desired value by applying high loop gain. The difficulty imposed by $C$ being a distributed element can be avoided by adding lumped capacitance.

If $\beta$ is real, $C$ should be kept as small as possible; if $\beta$ is complex it is $C_0$ which should be minimized.

However, the use of feedback-path integration may involve a time constant in the hundreds of millisec, and loop gain at power-line and audio frequencies may then be too low to obtain the desired reduction of ripple, hum and microphony. Consequently feedback integration is an optional feature in this electrometer and is used only when maximum bandwidth is the main requirement. Figure 1D shows a compromise solution which reduces the effect of $C_0$ by a predetermined factor. In the $\beta$ equation $k$ is in the range 0.1 to 0.25.

### Noise

In an electrometer the unusual input conditions are such that noise and drift levels may be comparable. Significant noise sources are thermal noise in the input resistor, noise due to statistical fluctuations of steady grid current, tube shot and partition noise (of uniform spectral density), and tube flicker noise.

About 20 $\mu$v of noise (rms) is possible; thus, corresponding peak-to-peak fluctuations may be of the order of 100 $\mu$v.

### Amplifier Design

Requirements, were for a sensitivity variable between $10^{-11}$ and $10^{-14}$ amp (fsd) with the best noise and drift performance possible, and a bandwidth of 0.2 cps at max sensitivity.

The highest available reliable value of input resistor was chosen ($10^{12}$ ohms) in the interests of signal-to-noise ratio and drift minimization. A loop gain of $10^4$ was then necessary to achieve the required bandwidth. Decade range variation by $\beta$-switching gives a loop gain of $10^4$ at $10^{-11}$ amp (fsd), when the input voltage is 10 v; since 10 v is also a convenient output voltage, 100-percent feedback can be employed in this range, and the forward gain is thus also $10^4$.

A single-ended high-gain electrometer stage with stabilized heater and plate supplies is used (Fig. 2). The British CV2348 (similar to the CK5886) is used. Tests on a number of tubes show a grid current of about $2 \times 10^{-15}$ amp and an effective heater drift of $\approx$ 30 mv per 1-percent filament-current fluctuation. Thus the zero offset due to grid current will be about 20 percent of fsd at $10^{-14}$ amp —which is unimportant if grid current is stable. If we assume 10-percent fluctuation, a zero uncertainty of only 2 percent of fsd results. The input voltage at $10^{-14}$ amp is normally 10 mv and therefore a filament current stability of 1 part in $10^4$ gives a drift of 3-percent fsd. An overall estimate of noise suggests probable peak-to-peak fluctuations of about 80 to 100 $\mu$v, or 1-percent fsd; thus, these three limiting factors have nearly equal effects, with drift predominating.

With a gain of 50 in the electrometer stage, the plate can be allowed 15-mv variation for 300 $\mu$v equivalent input. At 10-v plate voltage this variation is only a part in 700; a 1-in-$10^4$ supply for plate and filament is used. The second stage of the amplifier requires a heater-voltage stability of 1 part in 70 for 300-$\mu$v equivalent input. Since this requirement is easily furnished, the voltage-fluctuation drift of the whole amplifier can be about that of the electrometer tube filament.

The requirement for a loop gain of $10^4$ means that the frequency responses of individual stages may have to be controlled well into the mc region; a dominant time-constant is needed somewhere in the feedback loop. This time constant is located in the plate circuit of the stage $V_1$. The cable connecting the electrometer-tube stage to stage $V_2$ acts as loading capacitance.

### Head Amplifier

Stage $V_1$ is housed in a separate head. Tube $V_1$ operates at plate voltage and current of 10v, 5 $\mu$amp and 8.2-ma filament current. Pentode performance is maintained down to zero frequency by a 6-v Zener, diode $D_1$, across the screen; this diode must be selected to avoid fluctuations. The 2.5-$\mu$a screen current hardly loads the divider. Tube $V_1$ is biased by the voltage drop across $R_1$ and $R_2$. The plate resistance of $V_1$ is so high that it causes no significant zero-frequency degeneration. A gain of 43 is obtained from this stage.

Potentiometer $R_3$, which varies plate voltage of $V_1$, forms the fine set-zero control. As this control is inside the feedback loop, its effectiveness is decreased as loop gain increases—on the $10^{-11}$-amp range it has virtually no effect. Potentiometer $R_3$ is adjusted only

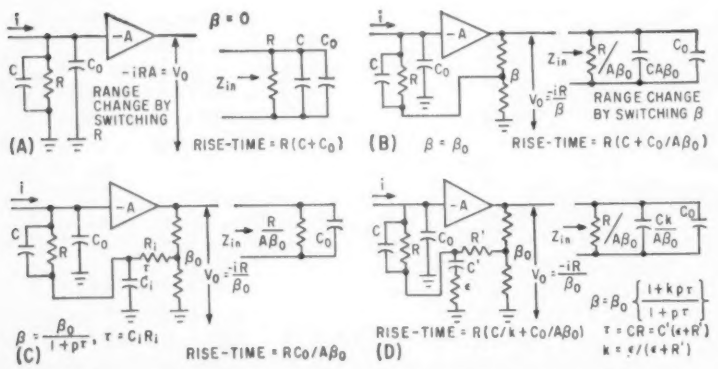



FIG. 1—Electrometer amplifiers without and with, feedback; without feedback (A); frequency-independent feedback (B); integrating circuit added to feedback loop (C); restricted-range integrating circuit in feedback loop (D).

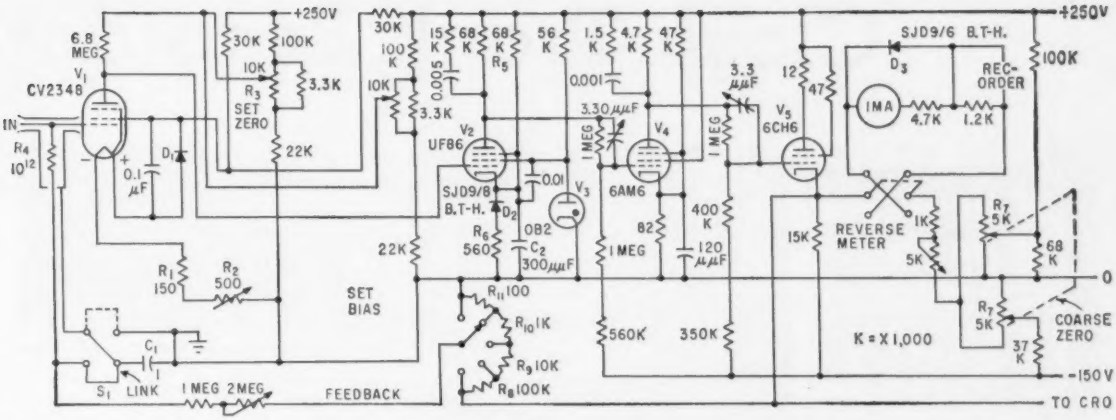



**Fig. 2—Coaxial cable connects the electrometer tube $V_1$ stage to the second stage of amplification. Link switch $S_1$ is in position that connects integrating capacitor $C_1$ to feedback circuit**

when $V_1$ is changed. Resistor $R_4$ is enclosed in a brass tube which forms a shunt capacitance of about 3 $\mu\mu$f.

The optional $\beta$-integration time-constant is located in the head to prevent shift of zero setting caused by leakage in the cable that links head and main amplifiers. Link switch $S_1$ removes capacitor $C_1$ and grounds the $R_4$ enclosure when $\beta$-integration is not required.

The first stage is loaded to cut-off at 100 cps (power-line ripple frequency) by the 235-$\mu\mu$f capacitance of the coaxial signal cable to $V_2$.

### Main Amplifier

Overall gain of stages $V_2$, $V_3$ and $V_4$ is 250. Tube $V_2$ has a stabilized d-c heater supply. The low (10v) plate level necessitates a cathode resistor which introduces zero-frequency degeneration. Impedance of the self-bias source is 560 ohms; this is provided by $R_5$ and $R_6$ combined with $D_2$, an 8-v Zener diode. Capacitor $C_2$ effects high-frequency compensation, raising the bandwidth from 187 to 374 kc.

After $V_2$, direct anode-grid coupling is not practicable. A stabilized negative line is required, but as there is high gain, anode stability requirements are nominal.

Gain to the grid of $V_1$ is 1,600, leaving a gain of about 7 to be provided. Assuming a cathode-follower gain of 0.9 and a coupling loss of 0.4, the actual gain required in $V_4$ is 19.5 with a possible anode swing of some $\pm$30 v. Tube $V_4$, a wide-band pentode, is chosen on gain-bandwidth considerations as its response must be controlled well into the mc region. Since a large (180-ohm) bias resistor would introduce too much degeneration, a bias voltage divider is used. Cathode compensation brings bandwidth up from 4.25 mc to 7.5 mc.

Coupling gain from $V_4$ to $V_5$ is 0.42, owing to the relatively high plate voltage of $V_4$. The output is taken from $V_5$ cathode, provision being made for recorder and cro in addition to the internal meter. The meter and recorder circuits are returned to the coarse set-zero control $R_7$. As this control is outside the feedback loop, its effect is independent of range setting. Zener diode $D_3$ provides meter overload protection by clamping at about 20 percent overload and reversal.

### Loop Gain and Stability

Range factors are provided by the $\beta$-divider $R_8$ to $R_{11}$. Resistor $R_{11}$ gives a loop gain of 9 to preserve the range factor of 10 throughout. The *no-feedback* range position provides a nominal sensitivity of $10^{-15}$ amp fsd, but is not normally used. Loop-stabilizing networks are included in $V_2$ and $V_3$ anode circuits. Since these networks operate well below the cut-off frequencies of their associated stages, the cut-offs are extended by factors equal to the h-f attenuation of the networks.

On the three least sensitive ranges, scale factor is within 1-percent accuracy and linearity as good as the meter. On the $10^{-11}$ amp range, the range factor was about 2½ percent in error.

The drift figure is good, though not equal to that obtained in certain investigations.[9, 10] Noise is about 3 times the calculated value, but since the analysis assumed input resistor noise no greater than thermal value and the flicker noise[11] is subject to uncertainty, the result is not excessively high. The current sensitivity approaches the practical limit estimated[12] for amplifiers using the voltage drop principle.

The author acknowledges the assistance and cooperation of R. Thorn, E. C. Fellowes, R. N. Bloomer, D. Pomroy. He is indebted to Dr. T. E. Allibone for permission to publish.

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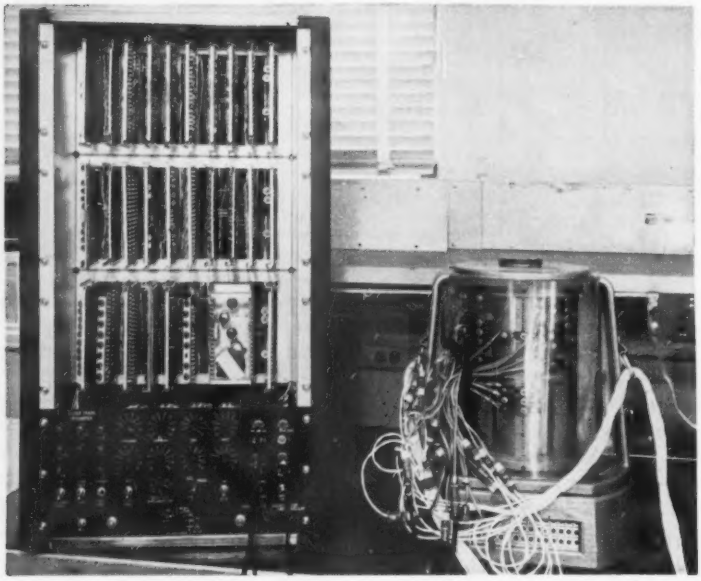
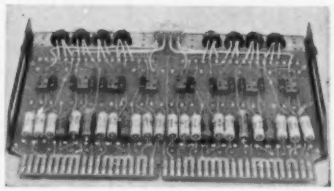
# Clock Track Recorder



Clock track recorder with the magnetic drum. Complete electronics with control panel are housed in the chassis at left



Card assembly containing two flip-flops

MAGNETIC DRUMS have found widespread use in data-processing systems as memory storage units. Drums are reliable and can store a great deal of information economically.

The magnetic drum can also serve to generate the basic timing signals for the entire system. At Hughes, a transistorized clock track recorder was developed that can write, automatically, any preselected number of timing bits on one channel of the drum. The recording heads are spaced in proper position around the drum periphery. A timing track on the drum channel synchronizes all the computational cycles and information flow to and from the memory. Signals are then distributed to the rest of the computing system.

Total power consumption of the unit is about 15 watts.

### Timing Signals

A block diagram of the transistorized clock track recorder is shown in Fig. 1. The central data source, module 9,999 counter, supplies all of the necessary timing signals used in both head setting and clock track recording. Four module 10 counters, connected in series, produce the total count of 9,999. Standard transistorized two-input flip-flops are used as the basic element, and diode gating accomplishes the proper timing. Since the counter is divided into four identical counters, the logical equations are the same for each, with the exception of an additional AND circuit to gate the following tens counter.

The counter can be reset in two ways: by an *RZ* origin pulse; and by the counter's own final output. The origin pulse is recorded on the drum by passing a transient current through the head while the drum is at a standstill. This records one *RZ* pulse in one spot on the drum.

The origin pulse is fed into the *OP* amplifier. The pulse is transformer-coupled to an a-c grounded-emitter stage. This, in turn, is transformer-coupled to a second a-c grounded-emitter stage. The output stage of the amplifier is transformer-coupled, but the base return of the transformer is returned to a bias point which is 2 volts more negative than the emitter return voltage. This puts the transistor in a cutoff stage until the signal overrides the bias and allows this stage to conduct.

The one-shot multivibrator supplies a gating voltage for the reset flip-flop. The multivibrator is a modified transistorized Eccles-Jordan flip-flop.

### Counter Output

The counter output sets up a gating voltage for the reset flip-flop, provides a scope sync and drives the *KK* write flip-flop. The writing amplifier is controlled by a switch, Write MOP-Clock Track. In the MOP position, the output of the $K\overline{K}$ flip-flop is connected to the input of the writing amplifier. In the clock-track position, the write amplifier writes all "1's" on the drum.

The clock-pulse amplifier and digit square-wave amplifier, Fig. 2, serves two functions: it generates clock pulses which drive all of the flip-flops in the system; and it generates digit square wave signals which are used only in the Manchester conversion network of the writing amplifier.

The input of the clock-pulse amplifier and digit square-wave generator comes from either of two sources: an external signal gen-

# For Memory Drum

**All-transistorized unit facilitates writing of timing signals on a magnetic drum. Recording heads, properly spaced around periphery of drum, automatically write any preselected number of timing bits on one channel of the drum, and synchronize all of the memory information**

By **A. J. STRASSMAN** Member of Technical Staff, Hughes Aircraft, Los Angeles
and **R. E. KEETER,** Member of Technical Staff, Aeroneutronics, Newport Beach, Calif.

erator provides the desired frequency for writing the time track; and timing signals, previously recorded on the drum, set up the bit spacing between the read and write heads.

The read amplifier and read flip-flop unit is used in conjunction with head space setting of the read and write heads. The input to the read amplifier comes from a reading head on the drum. The read-amplifier output goes to the read flip-flop and can be viewed with an oscilloscope.

### *Flip-Flops*

The *JK* flip-flop, Fig. 3, is a transistorized Eccles-Jordan switch, with the collectors clamped with diodes to stabilize the operating points. Grounded collector transistors, driven from the switches, provide the current for driving voltage stage gating circuits.

The $K\bar{K}$ flip-flop is really divided into a normal *JK* flip-flop with increased input capacitance at *J*, and a pulse-steering network. This network is driven by an *npn* emitter follower. The normal *K*-side clock pulse is AND'ed with the emitter follower output and the normal *J* side pulse is introduced through a 1,200 $\mu\mu$f capacitor. The pulse reference on the *J* side becomes essentially the input voltage level and is pulsed only if this level is at −6 v. At the zero-volt level, *J* pulsing is

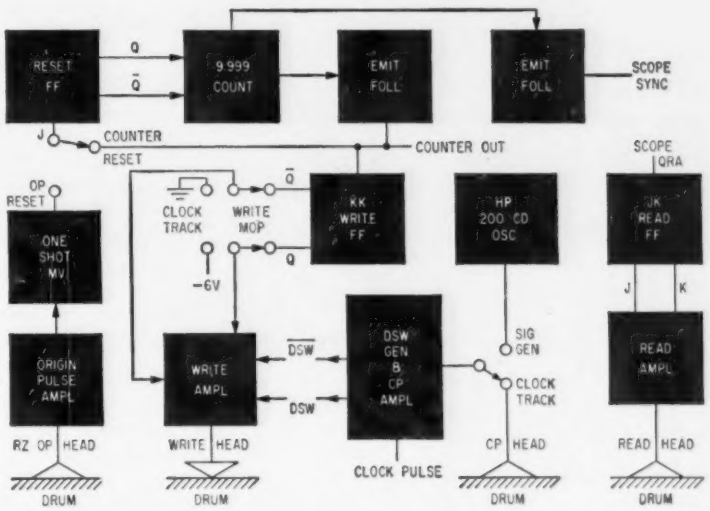



**FIG. 1—Block diagram of clock track recorder**

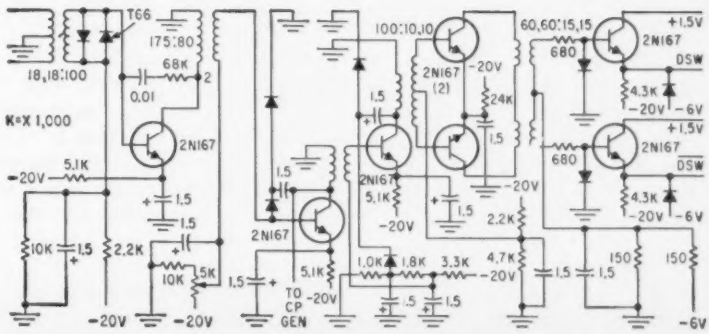



**FIG. 2—Clock pulse amplifier and digit square-wave amplifier**

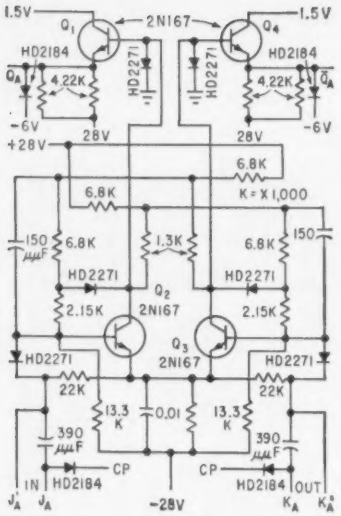



FIG. 3—The flip-flop circuit used with the read amplifier

prevented by a clamp decoupling diodes.

### Write Amplifier

The digit square wave generator receives the square-wave output of the read amplifier and produces two 0 (−6) volt square waves, $\overline{DSW}$ and $DSW$, phase displaced by 180 deg with respect to each other. These waves are utilized in the gating of the write amplifier for the Manchester conversion.

The write amplifier, Fig. 4, contains a power amplifier and impedance-changing device which is arranged to convert the voltage waveform at the output of the flip-flop into a corresponding current waveform in the low-impedance recording head. The driver consists of an a-c grounded-emitter input

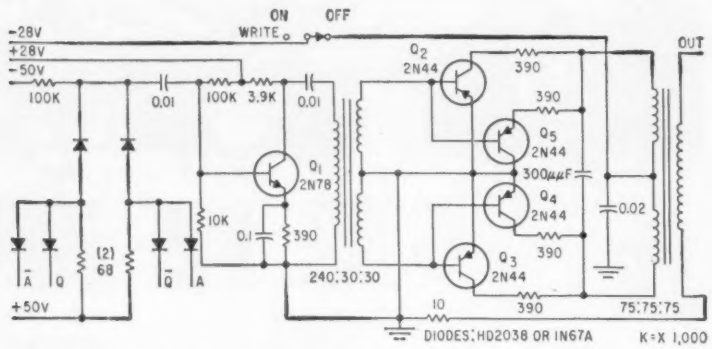



FIG. 4—Write amplifier contains a power amplifier and an impedance-changing device

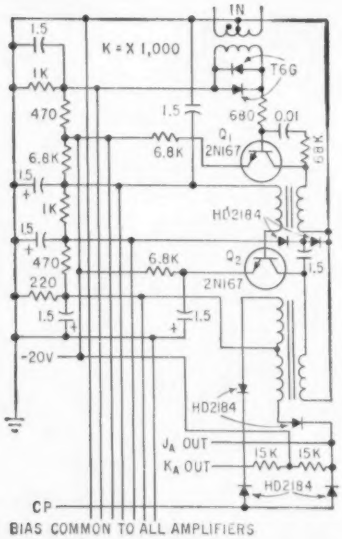



FIG. 5—Read amplifier for the reading head also used to synchronize

stage driven through a capacitor by the output stage through a 4 to 1 center-tapped step-down transformer.

The output stage of the write amplifier consists of a push-pull parallel Class B amplifier, using *pnp* transistors. The square-wave signal furnished by the driver's stage is transformer-coupled into the bases of the output stage and serves to switch the two sets of the output transistors alternately on and off to provide a current square wave in the output transformer.

The write amplifier supplies the proper current waveform for Manchester recording to the write head. A 220 ma peak-to-peak current is required by the write head winding with the head-to-drum spacing of 0.001 inches.

The read amplifier, Fig. 5, is used to amplify and synchronize. Amplification is necessary because of the low read-back voltage achieved with the low-impedance reading head. This voltage is primarily a function of the head-to-drum spacing although it varies inversely with magnetic cell density. The minimum read-back voltage that will be permitted is 0.06 volts, for independence of cross talk and other noise.

The signals from the amplifier output stage are essentially square waves, OR'ed with clock pulses, the outputs of the OR gates are applied to the inputs of the read flip-flop, and trigger it so that the information finally appears as voltage states of $QRA$ and $\overline{Q}RA$. These two output states go to the oscilloscope shown in Fig. 1.

The wave form of the read-back signal for the Manchester system of magnetic recording may be considered as a phase-modulated sine wave that is step modulated. Therefore some means of phase detection must recover the stored information.

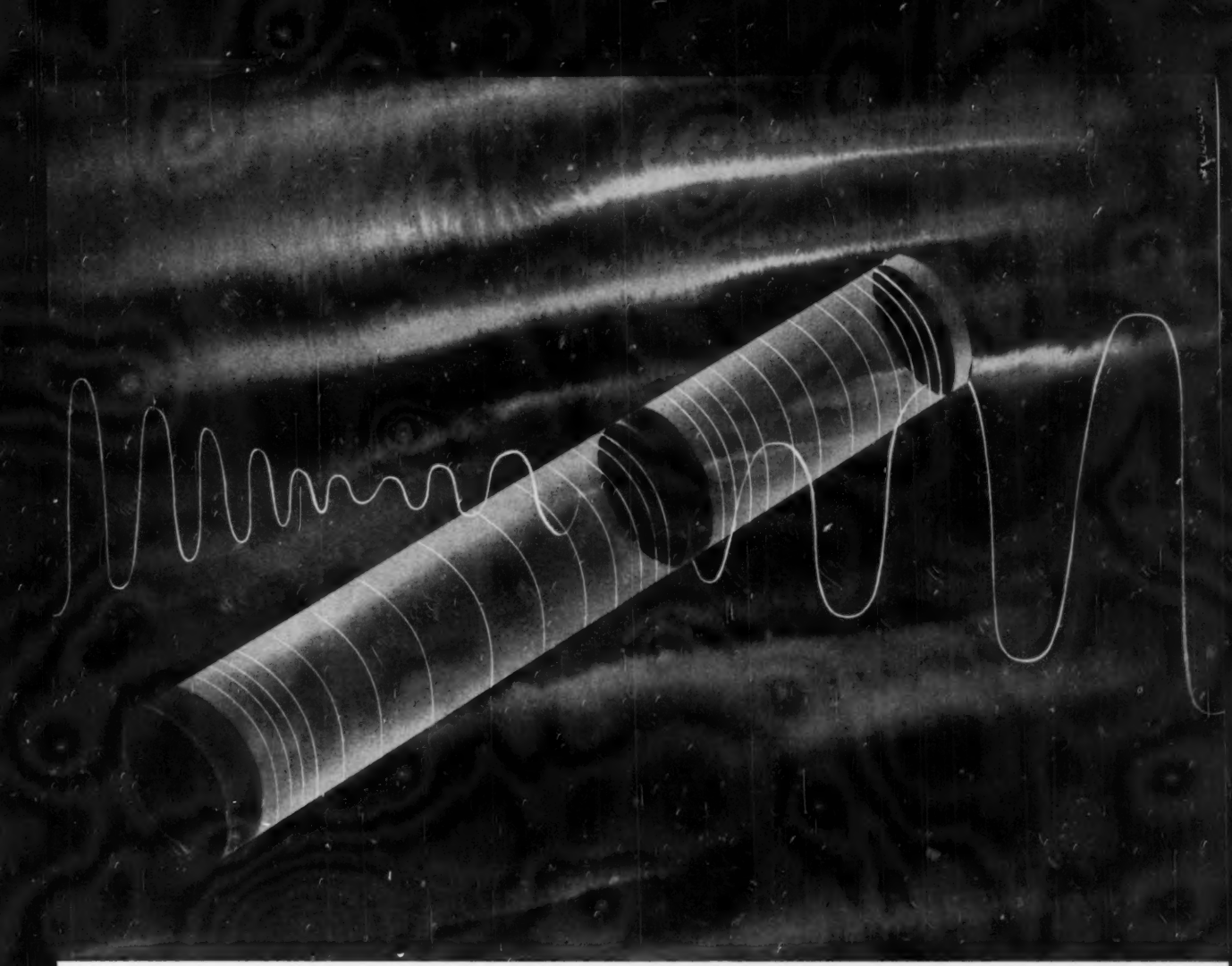
There are only two frequencies present in the signal received from the reading head—a sine wave of the bit frequency when the reading signal changes from one to zero, or vice versa. This permits use of a bandpass amplifier that must have little more than a two-to-one frequency pass band.

### Voltage Feedback

The amplifier portion of the read amplifier has an a-c grounded emitter input stage transformer coupled to a second grounded emitter stage. The first stage uses voltage feedback through the series 0.01 μf, 68-K resistor to increase the band width of the stage. Voltage clamps in the second stage protect the transistor against overswing as well as provide a plateau for the gating.

A 2.5:1: 1 stepdown transformer couples the second amplifier stage to the OR gates.

The two diodes connected back-to-back to the secondary of the input transformer produce a symmetrical limiter to insure reliable operation over a wide range of amplitudes of the input signal.



*Report from IBM* ◆ *Yorktown Research Center, New York*

## MATHEMATICS IN PURSUIT OF SUBSTANTIVE SOLUTIONS

As mathematics has advanced the physical sciences, so has the scientist's need for precise mathematical analogies spurred many new advances in mathematics. At the IBM Yorktown Research Center, a group of mathematicians are attacking a wide range of research problems in applied mathematics. Beyond immediate solutions, their work often leads to insights of a purely mathematical nature.

A project to study the mathematical theory of wave motion in compressible viscous fluids was stimulated by recent developments in new high-speed hydraulic engineering techniques. One problem involved wave motion in a compressible liquid in a tube containing a free mass. A Fourier analysis led to a new system of discontinuous orthogonal eigenfunctions, which are being studied further for their mathematical interest. At the same time the solution predicted effects of varying the physical design parameters, which are currently being tested in a mechanical model and its electrical analogue.

The stimulus to mathematical inquiry illustrated in this example from fluid mechanics characterizes the mathematics activity at IBM Research in a variety of fields. At present other studies are under way on mathematical problems in such fields as solid mechanics, electromagnetics, nonlinear oscillations and in numerical analysis.

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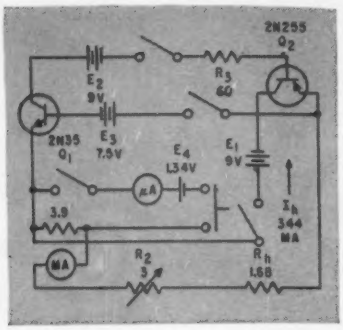


FIG. 1—Circuit used in moisture meter stabilizes heater current

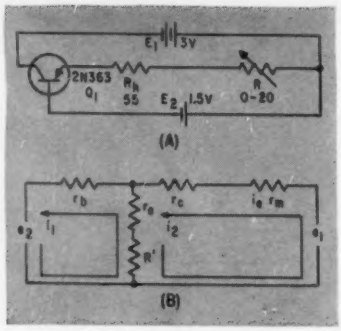


FIG. 2—Single transistor control circuit demonstrates circuit functions

# Inverse Feedback Stabilizes Dry Cell Current Sources

## Errors in test instruments that draw heavy current from dry cells are reduced with transistor circuit that maintains constant current

By **G. E. FASCHING,** Bureau of Mines, U. S. Department of the Interior, Morgantown, West Virginia

HIGH PERCENTAGE of negative feedback is used in transistor circuit to offset effects on dry cells of heavy current loading and consequent voltage decay.

### Moisture Meter

Meter for measuring moisture in pulverized coal or other powders required constant current supply from conventional zinc-carbon cells subjected to heavy loading. In the meter, six standard cells in series provide 344 ma to a 2-watt heater. Without control, current variation with time over the 20-minute test periods introduced errors.

The transistor version of a cathode follower in Fig. 1 provides direct compensation for limited battery voltage decay. A correction voltage, about equal to change in battery voltage but opposite in polarity, appears at the output of $Q_2$. The correction voltage is obtained by using inverse voltage feedback in a two-stage, direct-coupled amplifier. Voltages $E_1$, $E_2$ and $E_3$ are bias voltages; $E_4$ is a mercury cell used in a voltage null detector circuit for adjusting heater current $I_h$ through heater $R_h$ at the beginning of each test.

Adjustment of heater current at the start of each test is done with $R_2$, and $R_3$ provides enough voltage drop to prevent $Q_1$ from overheating.

For analysis, a simplified version of the circuit is shown in Fig. 2. It is accompanied by the a-c equivalent when small-signal T-parameters are used. Use of these is limited to operation within the linear region or a small region of the transistor characteristics.

### Analysis

To determine heater current change, $i_h$, that would result from voltage decay of $E_1$ and $E_2$, it was found that for a voltage change $e_1$ in heater source $E_1$: $i_{h1} = i_2 - i_1 = e_1 r_b / [(R' + r_c + r_e - r_m) r_b + (R' + r_c) r_c]$. For a voltage change $e_2$ in base bias $E_2$: $i_{h2} = i_2 - i_1 = e_2 r_c / [(R' + r_c + r_e - r_m) r_b + (R' + r_c) r_c]$.

Upon inserting values of typical junction transistor parameters and external circuit constants into these equations, it was found that a unit change in $E_1$ causes only a small change in heater current because of the large dynamic resistance. This resistance, being in the order of megohms, permits heater-current deviation of only microampere magnitude coincident with a unit volt change in the heater supply.

However, for voltage changes in base bias $E_2$, dynamic resistance is relatively small and significant heater current deviation occurs for a unit decay of base bias. This shortcoming is partly offset by the lower discharge (hence decay rate) of the source. Bias current relative to load current is dictated by the inherent forward d-c transfer ratio of the transistor used (normally 40-150).

### Performance

The circuit in Fig. 1 has high current stability in the 20-minute test period. Heater current varies less than 150 μa from the preset value of 344 ma. Without the control and under similar conditions, heater current deviation ranged from 8,000 to 15,000 μa. Stability improvement factor is over 50.

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# Computer Developments Revealed

DIODES are used to perform the role of a core-switching array in a memory under development at the University of Chicago's Institute for Computer Research.

Design of an 8,192-word, 54-bit memory using this technique and having a cycle time of less than $2 \times 10^{-6}$ sec was reported to the Association for Computing Machinery at MIT. Nearly 1,200 computer users and researchers attended the 3-day conference.

R. T. Shevlin of the AEC Computing and Applied Mathematics Center at NYU disclosed that GE 1N92 germanium junction diodes are used and 420-mil RCA experimental cores. He also reported development of a combination sense and digit drive line free from the effects of noise and post-write disturbance.

In the linear-selection diode-steered switch array, selection of a memory word is similar to that of the core switch array. A steering diode is selected by a coincidence of $X$ and $Y$ currents so as to cause current to flow in the selected diode and consequently through the cores of word 1. All remaining diodes stay cut off. Current in the selected diode results in minority carrier storage in its base, and this charge may be used for reverse memory drive.

### Core Geometry

To overcome effects of ringing on the sense line during and after rewrite, Shevlin reported a new type of core geometry was developed. By wiring the sense line as shown in Fig. 1, it appears as a balanced, loaded transmission line. It can be treated as a lossless line and terminated in its characteristic impedance. Impedance of the line can be controlled by core spacing. Sample lines have been constructed having between 200 and 400 ohms impedance and delay of 100 millimicroseconds for 4,096 cores. Because the line is balanced and twisted, it is practically immune to noise.

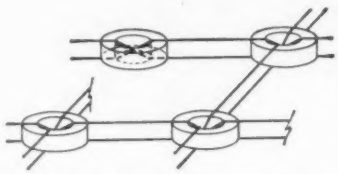


FIG. 1—Sense and digit drive line is wired so that effects of noise and post-write disturbance are eliminated

The Biax, a new magnetic computer element, was introduced to the ACM conference by W. E. Frady of Aeronutronic Systems. A small rectanguler bar of ferrite magnetic material has two orthogonal holes between which no conventional magnetic coupling exists. Rapid flux interference phenomena do occur, however, and may be made either destructive or nondestructive, depending on spacing between holes.

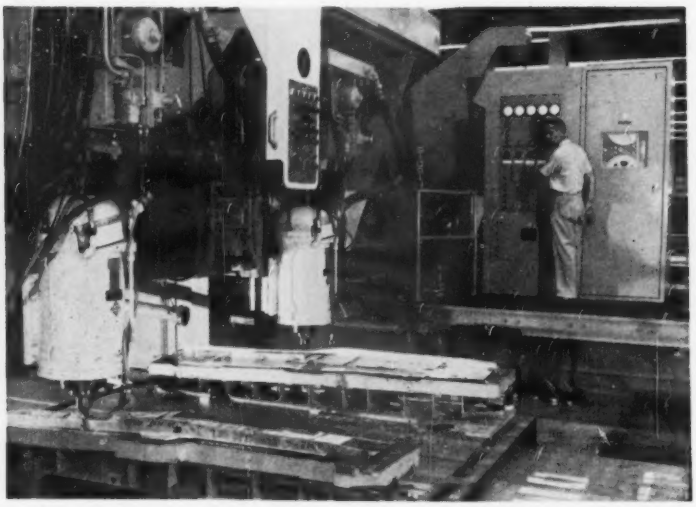
The destructive mode is used for logical gating functions and the nondestructive mode for memory.

### Automatic Design

Also described to computer users were new techniques for multiprogramming, time-sharing, information storage and retrieval, and automatic computer design. J. P. Malbrain and A. V. Banes of Thompson-Ramo-Wooldridge reported that automatic design procedures have greatly reduced lead time in building new computers. Instead of the logical designer producing a finished set of equations, a computer is used to check equations, derive details and point out trouble areas.

Digital computers are used, they reported, to simulate the logic, determine parts values, compute subunit loading, write wiring lists, design logic boards, and print checkout charts and maintenance charts. The techniques are presently being used in design and fabrication of a large-scale military computer.

## Programmed Tools Aid Jet Output



Tape-controlled profiler at Republic Aviation is one of a battery of such machine tools. Metallic punched tapes containing all of the data found on blueprints direct machines, which are greatly reducing time and cost of producing modern aircraft

## Radar Techniques Help Meteor Study

ASTRONOMERS at Havena, Ill., are studying meteor particles and their effect on radio transmission. Operators of an elaborate electronic system hope to discover the origin

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**Capacity Tolerance**—All tolerances to ± 1%.
**Insulation Resistance**—40,000 meg. x mfd. at 25°C but need not exceed 70,000 megohms.
**Case Styles**—Available in all case style variations in MIL-C-25A.

### Full rated to 125°C.

Type **616G** (Extended foil)
Type **617G** (Extended foil)

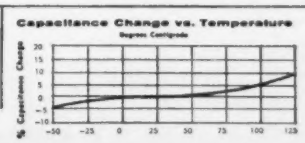
**Temperature Range**—Full rating to 125°C - to 150°C with 50% derating.
**Life Test**—500 hours at 125°C and 125% of rated voltage.
**Capacity Tolerance**—All tolerances to ± 1%.
**Insulation Resistance**—50,000 meg. x mfd. at 25°C but need not exceed 100,000 megohms.
**Case Styles**—Available in all case style variations in MIL-C-25A.

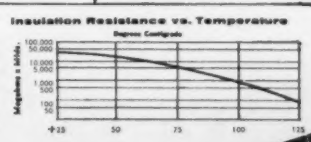
## 50-VOLT DIMENSIONS

| Capacitance in Mfds. | 626G* D | 626G* L | 627G D | 627G L | 628G* D | 628G* L | 629G D | 629G L | 616G*† D | 616G*† L | 617G† D | 617G† L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| .001 | .173 | 21/32 | .173 | 25/32 | .173 | 1/2 | .173 | 5/8 | .173 | 15/16 | .173 | 5/8 |
| .0022 | .173 | 21/32 | .173 | 25/32 | .173 | 1/2 | .173 | 5/8 | .173 | 15/16 | .173 | 5/8 |
| .0047 | .173 | 21/32 | .173 | 25/32 | .173 | 1/2 | .173 | 5/8 | .193 | 15/16 | .193 | 3/4 |
| .01 | .173 | 21/32 | .173 | 25/32 | .173 | 1/2 | .173 | 5/8 | .193 | 15/16 | .193 | 3/4 |
| .022 | .233 | 21/32 | .233 | 25/32 | .193 | 21/32 | .193 | 25/32 | .233 | 7/8 | .233 | 15/16 |
| .047 | .312 | 21/32 | .312 | 25/32 | .233 | 21/32 | .233 | 25/32 | .312 | 15/16 | .312 | 7/8 |
| .1 | .312 | 25/32 | .312 | 25/32 | .312 | 21/32 | .312 | 25/32 | .400 | 7/8 | .400 | 7/8 |
| .22 | .400 | 1 | .400 | 1 1/16 | .400 | 7/8 | .400 | 1 3/16 | .500 | 1 | .500 | 1 1/16 |
| .47 | .500 | 1 1/16 | .500 | 1 3/16 | .500 | 1 | .500 | 1 1/16 | .562 | 1 1/16 | .562 | 1 1/16 |
| 1.0 | .560 | 1 11/16 | .560 | 1 15/32 | .560 | 1 15/32 | .560 | 1 15/32 | | | | |

*These types have one lead grounded to the case. Others have both leads insulated.

†Also available in 150V, 400V & 600V ranges.

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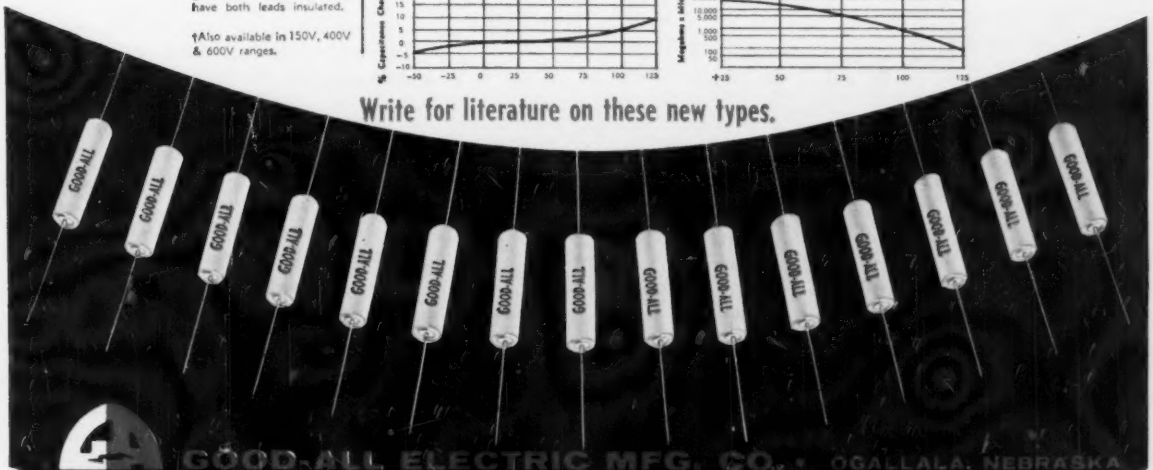


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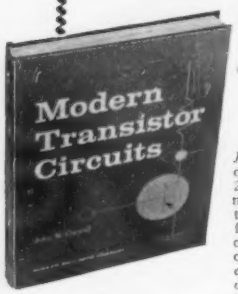


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of meteors, the physical processes involved when a meteor particle impinges on the upper atmosphere and to study the upper atmospheric winds.

The program, sponsored by the National Bureau of Standards, is under direction of F. Whipple, director of the Smithsonian Astrophysical Observatory and Professor of Astronomy, Harvard University, and Harvard's G. S. Hawkins, who was formerly associated with the Jodrell Bank Observatory, England.

**Guyed tower appears at right of one of the Raytheon radar receiver stations**

Though meteors have long been credited with reflecting radio signals over long distances, until recently meteor showers were considered too sporadic for practical use. When the scientists finish bouncing radio signals off meteor trails, their findings may eventually help extend the range of radio broadcasts.

The ionized air molecules resulting from meteor bombardment of the atmosphere can be used for reflecting transmitted signals similarly to the reflection process of the ionosphere. Ionization produced by meteors may contribute significantly to the general level of ionization of the night-time E region.

If the study proves that forward scatter signals are useful, the scientists expect to be able to predict direction of arrival of meteor particles from day to day. Reflection of signals from meteor trails may be more practicable for long-

range transmission than microwave relay satellites. By using this system of transmission, it may be possible to set up an almost continuous system of worldwide communications.

### *Equipment*

Using radar equipment, 40-mc pulses are transmitted at a peak power of 4 megawatts. Originally three receiver sites are being used. If the observation system meets expectations, the receiver network will be expanded to include six stations. Improved accuracy with six stations should enable astronomers to measure deceleration of meteor particles after they are in the atmosphere, which will increase accuracy of meteor orbital determinations.

Five radar receiver stations will be placed seven miles apart in a line running east and west, and another receiver station will be located seven miles north of the central station.

Echoes received from space by the radar receivers will be relayed to a central terminal. Output of the receiver i-f strip, which has a 200-kc bandwith centered at 3 mc, will be fed to a Raytheon microwave relay system transmitter. When the relayed i-f signals are received, they are then demodulated to video at the central terminal and applied to oscilloscopes for study.

A series of crt displays and a 70-mm camera will be used. From the time difference at which reflected energy is received at the receiver stations, astronomers can determine radiants and orbits of the meteors.

The antenna system for the Raytheon relay link is composed of 4-ft parabolic antennas and 6 by 8-ft passive reflectors supported by guyed microwave towers about 100 ft high. This type antenna-reflector combination has been found to provide adequate Fresnel Zone clearance over all obstacles along the microwave paths.

The microwave equipment eliminates need for laying cable to each location. The precision and speed with which the equipment is able to beam the signals was also a factor in it choice.

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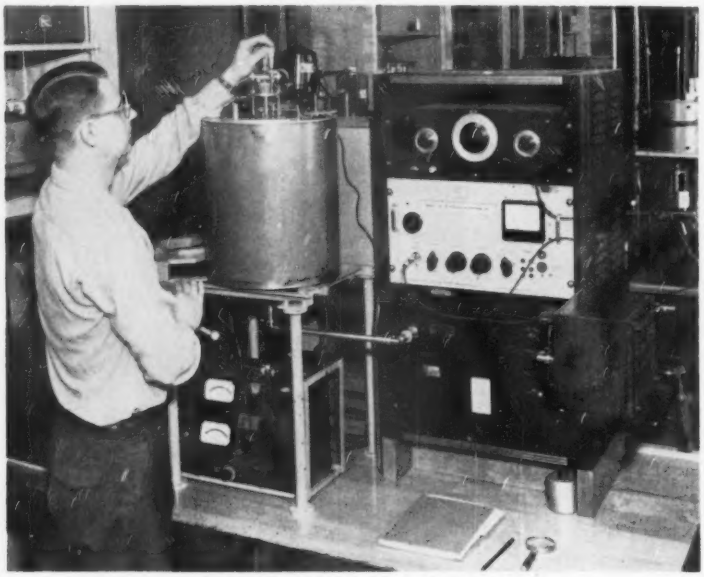
CIRCLE 83 ON READER SERVICE CARD 83

# Understanding Dielectric Materials



J. J. Weeks of the National Bureau of Standards is shown making a micrometer reading to determine the dielectric properties of a material undergoing a change of state. A special fusion cell is used for this work either with the bridge shown at the right, or the higher frequency resonant circuit located beneath the fusion cell housing

TO PROVIDE a better understanding of the properties exhibited by dielectric materials, the National Bureau of Standards is conducting a program of fundamental research sponsored in part by the Department of Defense.

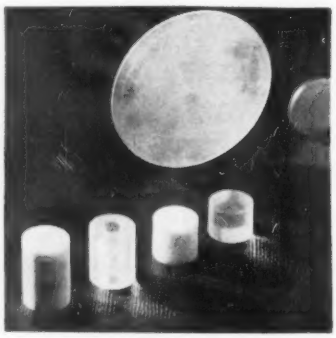
### *Behavior of Materials*

Primary objectives of this program are to explain observed dielectric phenomenon and to develop theories which can be used to predict the behavior of certain materials. In most of this work, a solid state approach is employed to probe the molecular behavior responsible for dielectric phenomena. These studies are complemented by efforts to improve the accuracy of dielectric measurements in the fields of electricity, electromagnetic waves, electronics, solid state research, polymer studies and physical chemistry.

During the past few years, demands for dielectric materials designed for specific applications have become more and more insistent.

In the missile and aircraft fields, for example, dielectrics with electrical properties that are relatively independent of temperature are needed.

To create dielectrics for special purposes in this way, the effects of various physical conditions on electrical properties must be determined, and the relationship between molecular behavior and electrical properties must also be established.



Group of specimens typical of those studied in the dielectrics laboratory. Small disk: electrode-plated poly (methyl methacrylate); large disk: polystyrene; opaque rods (first and third from left): polychlorotrifluoroethylene; clear rods: polystyrene. The most promising materials are those whose electrical properties are not greatly affected by humidity

Programs of dielectric studies, carried out by the Bureau's Dielectrics Section and Ferroelectricity group located in Washington, and the Radio and Microwave Materials section of the Boulder, Colo. Laboratories, provide concepts for such molecular engineering.

### *Dielectrics for Space*

Dielectric constants and dissipation factors are measured over a frequency range of 0.1 to $10^{10}$ cps at temperatures from −100 to 500 C. In addition, facilities for millimeter-wave work are available at Boulder and studies have been made at the low frequency end of the dielectric spectrum involving frequencies whose periods are days in length.

The Signal Corps is also supporting a program at Johns Hopkins University to determine what problems will arise and which dielectrics are most suitable for use in outer space. Nelson Terhune of the U. S. Army Signal Research and Development Laboratory in a report on dielectric materials for outer space, states: "Where it is determined that improved or special dielectrics are needed; work cannot be started too early a date because experience has shown that even with a vigorous and persistent effort, several years are always required to introduce a major improvement in a dielectric material."

Since various agencies directly concerned with the missile and satellite program are well aware of the new problems in the materials area which have arisen as a result of explorations into outer space, they have initiated several general investigations to study the behavior of available materials.

As evidence of the growing need to understand dielectrics a series of lectures in Materials and another in Insulation Practice are being held in New York City this fall. Both series will offer lectures by outstanding research specialists. The New York chapter of the American Society of Metals is sponsoring the series entitled "New

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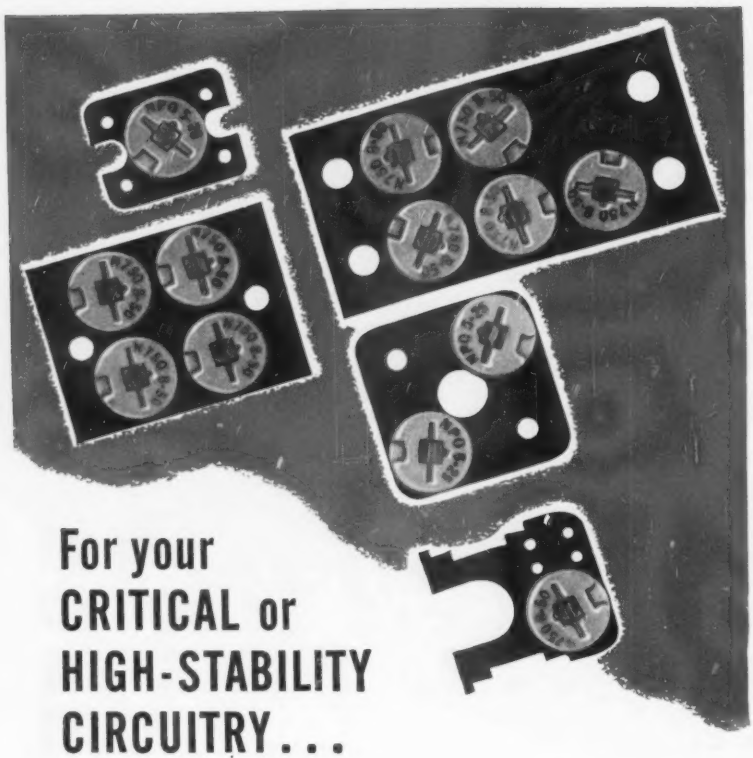

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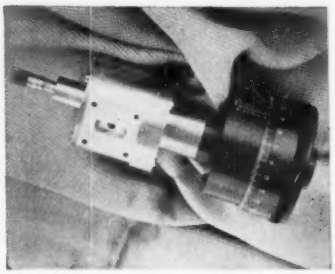
Materials for Advanced Applications: Missilery, Space, Electronics," and certificates will be awarded upon completion of the course. The New York section of the AIEE is sponsoring a series on "Developments in Insulation Practice." And various engineering groups all over the country are devoting more time for this area.

### *Radio and Microwaves*

In the interaction between electromagnetic waves and matter, conductivity properties of materials are essentially inseparable from the dielectric properties. At radio and microwave frequencies, studies are therefore an important component of any dielectric program. In this connection, the Radio and Microwave Materials Section of the National Bureau of Standards is investigating the tensor or directional conductivity of semiconductors, such as single crystals of germanium, at microwave frequencies under different physical conditions. Some important questions in the theory of solid state will be investigated in this work. It is expected that these studies will yield a better understanding of the crystal lattice forces and processes. The results may prove of value in microwave engineering if the tensor properties for radio waves are appreciable.



**Wavemeter with a precision of about 3 parts in a million, developed by the National Bureau of Standards for accurate dielectric measurements**

Propagation of electromagnetic waves or radio signals through a material is governed by the product of the material's magnetic permeability and its dielectric constant. For many substances the magnetic permeability is unity. In such cases the travel of waves in the material

is dependent only on the complex dielectric constant or the ability of the material to store electrical energy. In this connection studies are being conducted on the dielectric properties of various propagation media, such as ferrite, soils, tar sands, and oil bearing sandstones. Ferrites have important magnetic properties at radio and microwave frequencies and have directional characteristics important in microwave applications. They also have very high dielectric constants which are currently being investigated.

### *Oil Deposits*

Studies on soils are important in locating radio transmitters and antennas and establishing and predicting radio communication links. Tar sands and oil bearing sandstones contain valuable oil deposits which do not flow under their normal temperature environment in which the tar sands and paraffin in oil are solid. By application of suitable radio or microwave energy, it is hoped to tap these resources by warming the deposits sufficiently for flow. Properties of composite dielectrics are of interest.

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**As a Tachometer**—with photoelectric or magnetic angular speed pickups.

**As a Flow Rate Indicator**—with turbine-type flow transducers.

**As an Indicator** of Pressure, Temperature, Acceleration, Velocity, Force using any transducer which generates a frequency proportional to input.

**SPECIFICATIONS:**

**Maximum Count:** 9999, 4 digits
**Counting Rate:** 10 to 120,000 cycles per second
0 to 120,000 cycles per second
220 KC optional
**Input:** Sensitivity: 50 mv rms
150 volts maximum
Impedance: Approximately 100,000 ohms
**Display Time:** 0.2 to 6 seconds
**Time Bases** (Gate Times):
0.01, 0.1, 1 second
**Accuracy:** ± 1 count ± stability
**Stability of 10 KC Time Base:** 0.01 percent
**Size:** 6" high, 8½" wide, 10" deep
**Weight:** Approximately 10 pounds
**Power Requirements:**
105 to 125 volts, 60 to 420 cps, 40 watts
**Model 100TR** (Rack-mounted model)
Size: 19" x 7" panel, 10" deep

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# Tube Parts Welded Semiautomatically

By J. F. STEWART, Electron Tube Division, Radio Corp. of America, Marion, Ind.

STUDS SUPPORTING the glass insulating rods of electron gun structures were formerly welded in place on fixtures manually loaded and operated. A semiautomatic machine was developed which increased the production rate by 400 to 500 percent.

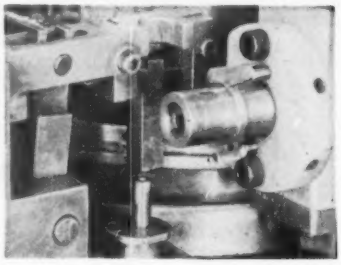
Two types of studs are used: nail head studs and staple studs. Both have flattened ends to provide a better grip in the glass. The flattened ends must be oriented lengthwise in the glass to provide adequate strength. The machine was originally developed to handle nail head studs and has been more recently modified to handle staple studs.

A fully automatic machine, with stud forming mechanisms and weld inspection devices, was considered and rejected. The low cost of the semiautomatic machines allowed a machine for each gun part, assuring flexibility. Use of operators provides full inspection and reduced scrap.

Staple stud welding machine in use. Electron gun cups are positioned on mandrel by hand, but remaining operations are automatic

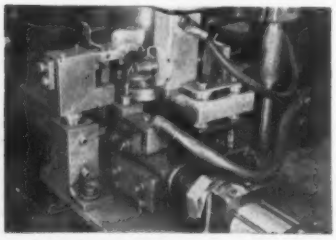
### *Nail Head Machine*

Nail head studs progress up the spiral track of a vibratory feeder. After passing a pressure relief point, they drop head up into a special track which guides them in a row to the feed tube, from which they drop into an electrode. The gating device is simply a cross pin escapement actuated by a straight slide-bar. The vibration of the feed tube rotates the stud. When the flattened end is aligned with a slot in the electrode, the stud is oriented and falls into welding position.



Closeup of nail head escapement, electrode and mandrel. Nail head is visible at top of tubular electrode

The cross slide which carries the electrode is driven by an air cylinder. After the electrode is loaded it is retracted to welding position under the mandrel. After welding, the cross slide returns to loading position. As it returns, a cam moves the escapement slide bar, via a roller, dropping another stud into the feed tube.

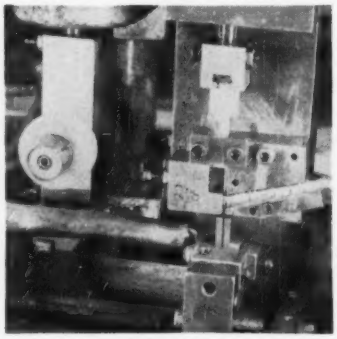


Nail head stud welding machine. Escapement cam is wedge on side of electrode cross slide. Head guide pins are at right of mandrel

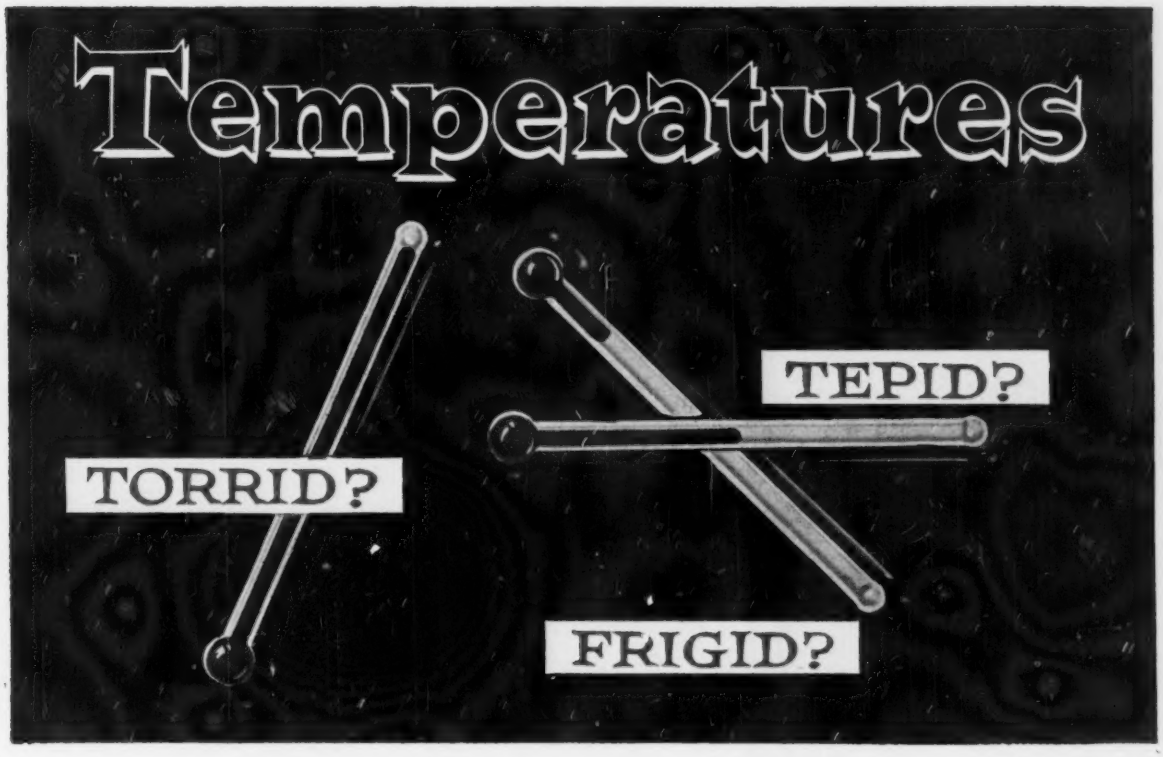
### *Mandrel Operation*

The mandrel which holds the gun cup provides radial and longitudinal control of stud placement. It projects through the machine head and is guided and spring-loaded at the rear. The standard weld head was modified with head guide pins and linear ball bearing bushings to improve accuracy.

The operator places a cup over the mandrel and welds the first stud. The mandrel is pushed inward until the first stud is against a stop pin, then the second stud is welded. The mandrel is released, comes forward, is hand rotated 90 or 180 degrees and the next pair



Plunger mechanism at top right pushes staples off track and into slotted electrode. Gun part is in mandrel at left

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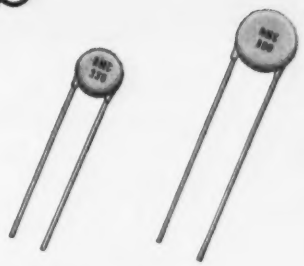
Type JL DISCAPS also offer the advantages of longer life, dependability, and lower cost. Write on your letterhead for additional information on these and other DISCAPS.



## SPECIFICATIONS

POWER FACTOR: 1.5% Max. @ 1 KC (initial)

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TEST VOLTAGE (FLASH): 2000 V.D.C.

LEADS: No. 22 tinned copper (.026 dia.)

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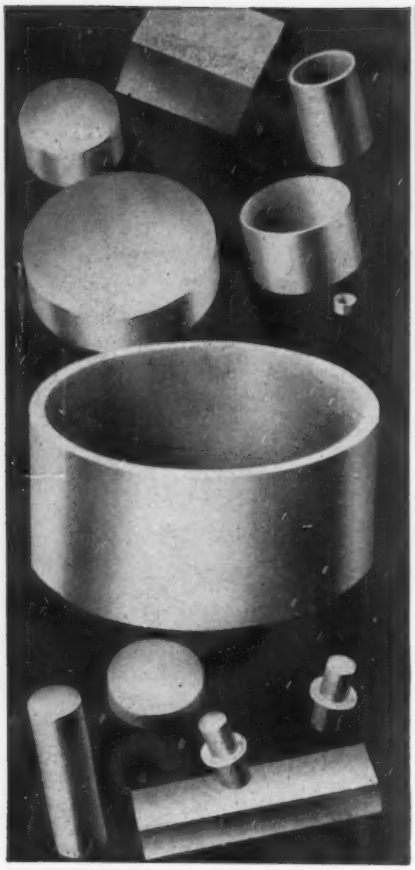

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PROPERTIES

| | US600 | US500 | US100 |
|---|---|---|---|
| Dielectric Constant | 1350 | 1200 | 500 |
| Curie Temperature | 310C | 330C | 150C |
| Rad. Coupling Coefficient | 0.46 | 0.50 | 0.31 |
| d Constant ($d_{33}$) | $-120\times10^{-12}$ | $-170\times10^{-12}$ | $-62\times10^{-12}$ |
| g Constant ($g_{33}$) | $25.3\times10^{-3}$ | $38\times10^{-3}$ | $31\times10^{-3}$ |

Transducer elements are intended for use as drivers, resonators, and sensors.

Applications include: missile systems, underwater sounding, thickness detectors, depth and liquid level sensing gages, IF filters, ladder networks, microphone elements, and power drivers.

*For further information write or call:*

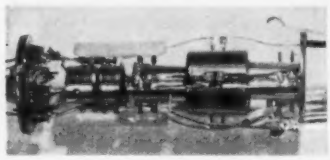
U. S. SONICS CORPORATION
625 McGRATH HIGHWAY · SOMERVILLE 45 · MASSACHUSETTS
MOnument 6-5100


of studs is welded.

A cylinder, cam, valve and switch mechanism replaces the standard welder foot pedal mechanism and drives the welding head. Other added controls are a synchronous weld timer and the amplitude regulator of the feeder.

### *Staple Stud Welder*

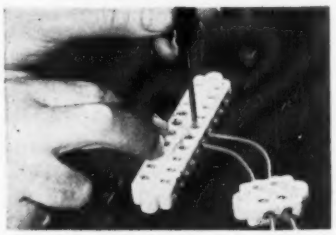
A new feed mechanism was devised for staple studs. These studs are made to straddle a feed rail.



**Part of electron gun, using staples rather than pairs of nail head studs**

As they leave the vibratory feeder, they are gravity fed to the throat of a transfer. The transfer cylinder drives a plunger which in turn drives each stud into the fully slotted electrode. A cross slide carries the electrode under the mandrel, which is then brought down to the stud as with the nail head welder.

## Cam Locks Wires in New Connector Strip



**Screwdriver is used to make or break connection**

RECENT DESIGN for quick connect-disconnect wire connector strips and terminal boards employ small die-cast V-groove cams. The cam action locks one or more bare wires in position until the cam is backed off with a screwdriver.

The connectors are made by Willor Mfg. Co., New York. Cams are zinc alloy, die cast by Gries Reproducer Corp., New Rochelle, N. Y.

Cam design is shown in Fig. 1. They have a screwdriver slot on the

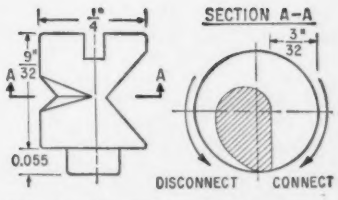
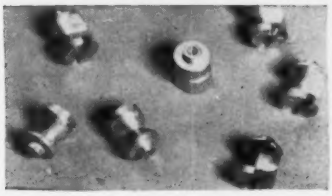



FIG. 1—Profile and cross-section of cam



Cams are zinc alloy, automatically diecast

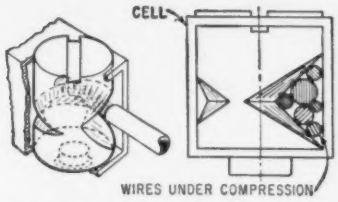



FIG. 2—Wires are locked between cam groove faces and cell wall

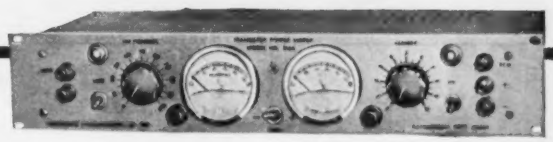
top and a pivot boss on the bottom. As the cam turns on the pivot, the groove forms a triangular opening with a metal cell wall which is almost tangent to the cam. The groove varies in width, depth and angle along its length.

Wire ends are inserted in the groove (Fig. 2). As the cam is turned toward the wire (clockwise), the cam surface wedges the wires against the cell wall. Tension, tending to pull the wires free, causes the cam to rotate clockwise, locking the wires more firmly in place. The wires can be disconnected by turning the cam counterclockwise. The locking action reportedly gives good electrical contact without crimping or solder.

Die casting is used for the cam because the shape is difficult to machine economically and accurately, and tool marks and burrs could not be removed satisfactorily by tumbling. Cams are nickel plated. The cams are dropped into position in metal cells so that the pivot bosses protrude through a pivot hole in the cell bottom. The bosses are swaged into rivet heads and the plastic housing screwed into place over the cells.


# 1 *REGATRON POWER SUPPLY DOES THE WORK OF 3 ORDINARY POWER SUPPLIES

**a case history**



(Model 212AM: 0-100 V dc, 0-100 ma, $129.00 unmetered)

A MANUFACTURER required three different regulated voltages. The voltages, which were to be used alternately, could be furnished by three separate power supplies or by a single power supply and a voltage divider. But, three power supplies were expensive. On the other hand, a voltage divider meant a loss of power and regulation plus the expense of high-wattage components.

THE SOLUTION: Three 1-watt resistors and a *Regatron Programmable Power Supply. An exclusive programming feature permits changing output voltage by shunting two terminals with a resistor. For each 1000 ohms, the Regatron delivers one volt . . . at rated current and regulation.

IN THE PROBLEM quoted here, the required voltages were 14.5, 28, and 45 V dc. The three resistors were 14.5K, 28K, and 45K. Regatron Programmable Power Supplies are available in many ranges up to 600 V dc and 3 amperes. Bulletin 765A tells more about how Programmable Regatrons solve d-c problems. Write for your copy.

## TRANSISTOR TYPES

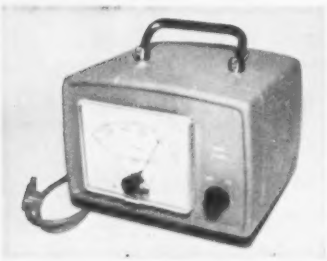
| MODEL NUMBER | OUTPUT | | REGULATION | | | | MAXIMUM RIPPLE IN MV |
|---|---|---|---|---|---|---|---|
| | | | LINE 105—125 V AC 50—60 CPS | | NO LOAD TO FULL LOAD | | |
| | Voltage | Current | % | V | % | V | |
| 212A[1] | 0—100 V DC | 0—100 MA | 0.15 | 0.05 | 0.1 | 0.05 | ½ |
| 2-212A[1] | EQUIVALENT TO TWO MODEL 212A's. OUTPUTS MAY BE USED IN SERIES, PARALLEL, OR INDEPENDENTLY. | | | | | | |
| 224A[1] | 0—100 V DC | 0—200 MA | 0.15 | 0.05 | 0.1 | 0.05 | 1 |
| 220A | 0—50 V DC | 0—500 MA | 0.1 | 0.05 | 0.1 | 0.05 | 1 |
| 221A | 0—100 V DC | 0—500 MA | 0.1 | 0.05 | 0.1 | 0.05 | 1 |
| 213A | 0—50 V DC | 0—1 AMP | 0.1 | 0.05 | 0.1 | 0.05 | 1 |
| 214A | 0—100 V DC | 0—1 AMP | 0.1 | 0.05 | 0.1 | 0.05 | 1 |
| 215A | 0—50 V DC | 0—3 AMP | 0.1 | 0.05 | 0.1 | 0.05 | 1 |
| 218A | 0—100 V DC | 0—3 AMP | 0.1 | 0.05 | 0.1 | 0.05 | 1 |

1. Modulation input provided for measurement of transistor parameters by small signal method.

* Registered U.S. Patent Office. U.S. Patents Issued and Pending.

ELECTRONIC MEASUREMENTS COMPANY, INCORPORATED
EATONTOWN • NEW JERSEY

# On The Market



## Tachometers
### versatile units

AIRPAX ELECTRONICS INC., Seminole Div., Ft. Lauderdale, Fla. Speed or rpm problems are simplified by the series 7000 tachometer line. Providing better than 1 percent accuracy, they employ semiconductors and a saturating transformer to maintain high reliability and long life. Input signals may be supplied by electromagnetic, photoelectric, and proximity pickups, tachometer generators, turbine type flowmeters or any instrument delivering an output frequency proportional to rpm. Amplitude of the input signal may be as low as 0.005 v rms.

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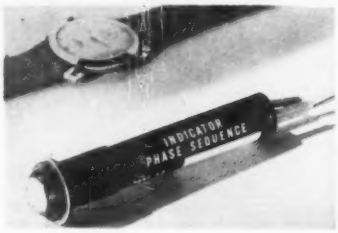
## Indicator
### phase sequence

MASTER SPECIALTIES CO., 956 E. 108th St., Los Angeles 59, Calif. Unit is designed for permanent installation on airborne or ground equipment to monitor the phase sequence of a 3-phase power supply; qualified per MIL-E-5272A; fail-safe in that incorrect phase sequence, or disconnected lead will not allow the neon lamp to illuminate; operates over a wide range of ambient temperature, voltage, and frequency. All static components insure long life.

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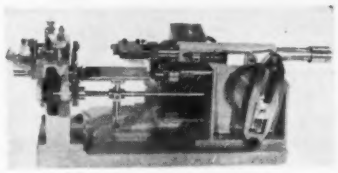
## Wire Stretcher
### and cutter

THOMAS INSTRUMENT CO., Phoenix, N. Y. Compact machine is designed to automatically straighten, stretch and cut fine wire to a preset length. Operated by a ratiomotor, the quiet, rugged, bench-type machine works at the rate of 2,280 pieces per hr of 3¾ in. long No. 36 wire. Dimensions are 10 in. deep, 32 in. long and 9 in. high.



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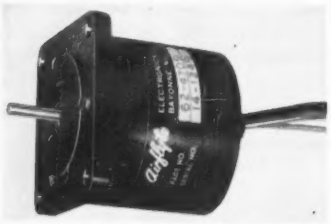

## Commutator
### lightweight unit

AIRFLYTE ELECTRONICS CO., 535 Ave. A, Bayonne, N. J. A miniature switching commutator features low noise, low torque, long life and angular accuracy of 10 minutes of arc. It is available either motor driven or hand detented and meets Specs 5400 and 5272. Unit is ideal for programming, data processing, selecting, telemetering, high-speed sampling, analog-digital conversion, sync drives, multipole and multithrow switches and sinusoidal switches.

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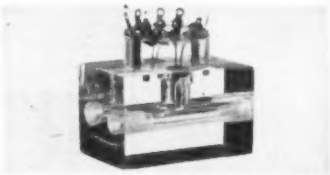
## Thermal Cells
### fast, accurate

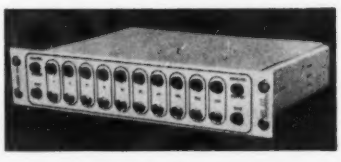
VICTORY ENGINEERING CO., 524 Springfield Rd., Union, N. J. Gas analysis, gas chromatography and sampling or control or analysis of chemical processes are made easier with VECO thermal conductivity cells. The sensitive cells contain a matched pair of glass coated, bead type thermistors which may be conveniently connected into any desired external circuit configuration.



**CIRCLE 204 ON READER SERVICE CARD**

## Converter
### digital to analog

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa. Model 141A ladder network sums ten flip-flop outputs from binary counters or shift registers, and produces bi-polar current proportional to count. Proportional current may be applied to control devices for continuous monitoring of digital



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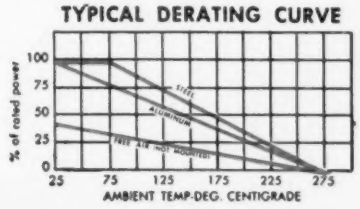
**HIGH POWER • WIRE WOUND • MINIATURE**
**DALOHM TYPE RH RESISTORS**

Designed for specific application of high power requirements, coupled with precision tolerance. Mount on chassis for maximum heat dissipation.

**TYPICAL DERATING CURVE**

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- **Operating temperature range** from −55° C. to +275° C.
- **Welded construction** from terminal to terminal.
- **Ruggedly housed;** sealed in silicone and inserted in radiator finned aluminum housing.
- **Smallest in size,** ranging from 7/16" x ¾" to 3" x 4½"
- Surpass applicable paragraphs of MIL-R-18546B (Ships).

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- Speed Production
- Cut Assembly Costs

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**WRAP-A-WIRE TERMINALS**—Quickly inserted. Exclusive staked clinch-type feature locks terminal firmly until permanently soldered.

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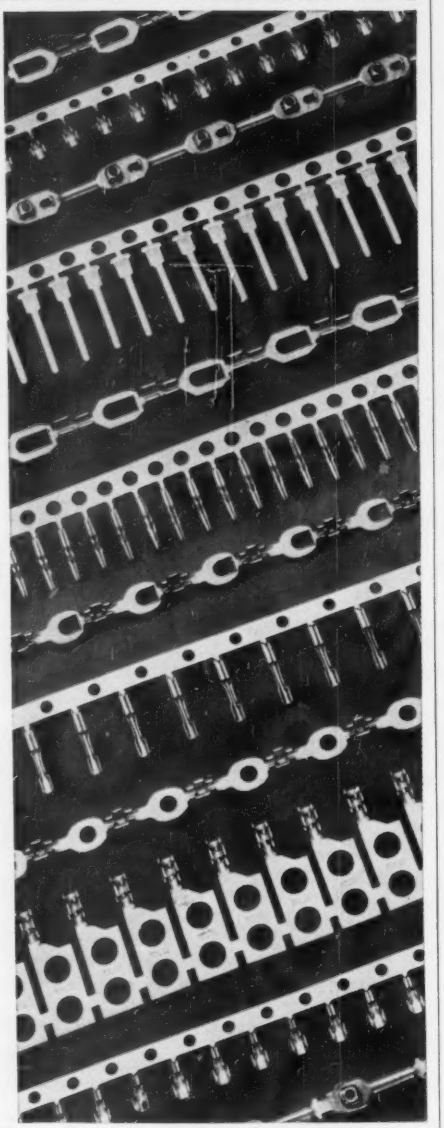

*Registered Trade Name

Malco MANUFACTURING COMPANY

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data. As a step-function generator, the size and number of steps are easily varied. Unit is a standard slide-in module measuring 2¼ by 10¾ by 7 in.

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## Band Pass Filter
## 170 cycle spacing

HERMETIC SEAL TRANSFORMER CO., 555 N. Fifth St., Garland, Texas. Hermetically sealed receiving filter for multiplex telegraph systems offers 18 channels with high interchannel attenuation, flat pass bands and excellent harmonic rejection. Center frequencies, 425 cps through 3,315 cps; frequency response: center frequency, 0 db; 25 cps either side, down not more than 1 db; 50 cps either side, down not more than 5 db; 145 cps either side, down at least 40 db.

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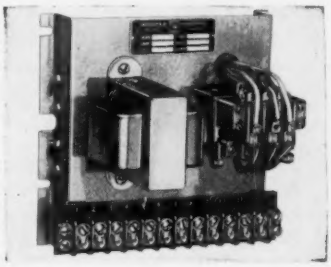

## Pilot Relays
## long life

WEBSTER ELECTRIC CO., Racine, Wisc. PR series pilot relays are used generally as single or dual level controls (pump in or out), high or low level alarm, contact meter amplifiers, liquid leak detectors and temperature detectors. Life, maintenance, installation and

# SYNTHETIC SAPPHIRE FOR HELIX SUPPORTS

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Single crystal synthetic sapphire rods are being used as support members for TWT helices and electron gun structures.

Sapphire offers flexural strength at elevated temperatures, excellent dielectric properties, small-diameter rigidity, strength at elevated temperatures, low-loss characteristics, zero porosity, and economy.

In addition to rods, single crystal sapphire is available in the form of windows and domes for microwave and infra-red systems. Special sapphire shapes for custom applications can be obtained.

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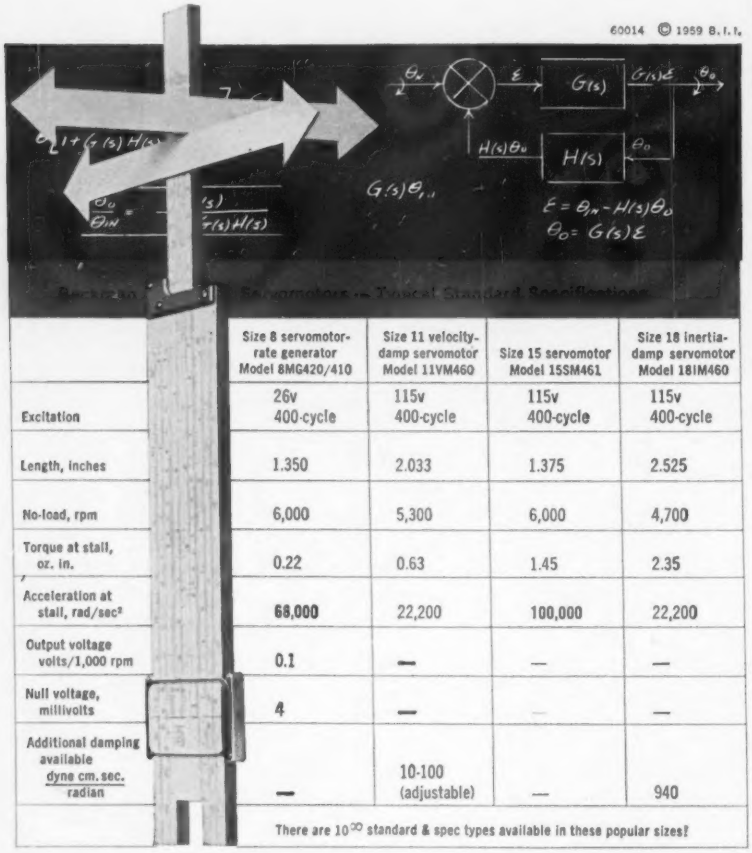


| | Size 8 servomotor-rate generator Model 8MG420/410 | Size 11 velocity-damp servomotor Model 11VM460 | Size 15 servomotor Model 15SM461 | Size 18 inertia-damp servomotor Model 18IM460 |
|---|---|---|---|---|
| Excitation | 26v 400-cycle | 115v 400-cycle | 115v 400-cycle | 115v 400-cycle |
| Length, inches | 1.350 | 2.033 | 1.375 | 2.525 |
| No-load, rpm | 6,000 | 5,300 | 6,000 | 4,700 |
| Torque at stall, oz. in. | 0.22 | 0.63 | 1.45 | 2.35 |
| Acceleration at stall, rad/sec² | 68,000 | 22,200 | 100,000 | 22,200 |
| Output voltage volts/1,000 rpm | 0.1 | — | — | — |
| Null voltage, millivolts | 4 | — | — | — |
| Additional damping available dyne cm. sec. / radian | — | 10-100 (adjustable) | — | 940 |
| | There are $10^{20}$ standard & spec types available in these popular sizes! | | | |

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## Megohmmeter six ranges

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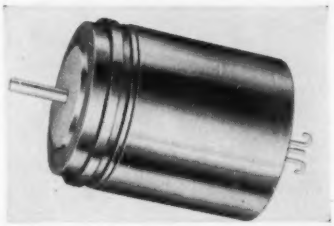

## Servostepper for airborne use

GIANNINI CONTROLS CORP., 918 E. Green St., Pasadena 1, Calif. Model 1500C, size 15 Servostepper for high accuracy airborne applications: volume, 2.8 cu in.; weight, 4 oz.; rate, 90 steps per sec (in some applications, 160 steps per sec). Withstands 50 g shock, 75 g steady state acceleration in any axis, and temperatures from −55



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The University of Michigan's Dr. Norman Scott *(left)* demonstrates the Michigan Instructional Computer—only unit of its kind in the world—to Strand Engineering Company's Robert Carson who is working for his Ph. D.

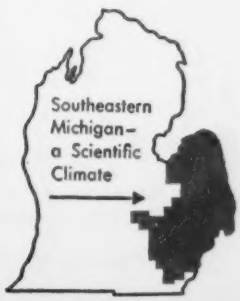
## IN SOUTHEASTERN MICHIGAN:

# A SCIENTIFIC CLIMATE FOR THE ELECTRONICS INDUSTRY

Electronics companies in Southeastern Michigan have an invaluable asset right from the start. Their personnel find advanced schooling readily accessible. In the area are conveniently located science schools whose postgraduate and extension facilities and faculties are comparable with the best available anywhere.

Within easy reach of these competent schools are communities which have carefully organized and blueprinted their prosperous growth. Done by skilled professional land-use planners, it's the kind of planning which reassures management people concerned with plant location. Such communities can be particularly confident when they extend an invitation to the electronics industry to look them over. We, too, would welcome the opportunity to discuss communities and plant sites with you on a completely confidential basis.

*(Left)* Analog computer, Michigan State University. *(Center)* One of the modern College of Engineering buildings, Wayne State University. *(Right)* University of Detroit engineering students conduct electronic experiments in the characteristics of gravity.




*Write to Plant Location Service, Area Development Division*

**DETROIT EDISON**

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C to +71 C. Can be coupled or provided with built-in potentiometers and other control devices.

**CIRCLE 209 ON READER SERVICE CARD**

## Phase Detector
### versatile unit

BOONSHAFT AND FUCHS, INC., Huntingdon Valley, Pa. The visual phase sensitive detector is used in performance evaluation of a-c servo systems and similar devices employing carrier modulation. Used with any oscilloscope it provides a visual demodulation of the carrier with no phase shift or time delay. Phase and amplitude distortion are zero, regardless of the carrier frequency. Quadrature and even harmonic rejection are on the order of 100:1, making the crossover point free of hash and noise.

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## Tv Camera
### pencil type

DIAMOND POWER SPECIALTY CORP., Lancaster, Ohio. C-C tv camera built to operate inside reactor tubes 3 in. in diameter. Permits inspection of reactor tube welds without pulling tubes from pile. Stainless steel reactor tubes blacken under radiation, but defective welds remain clean and show as white areas


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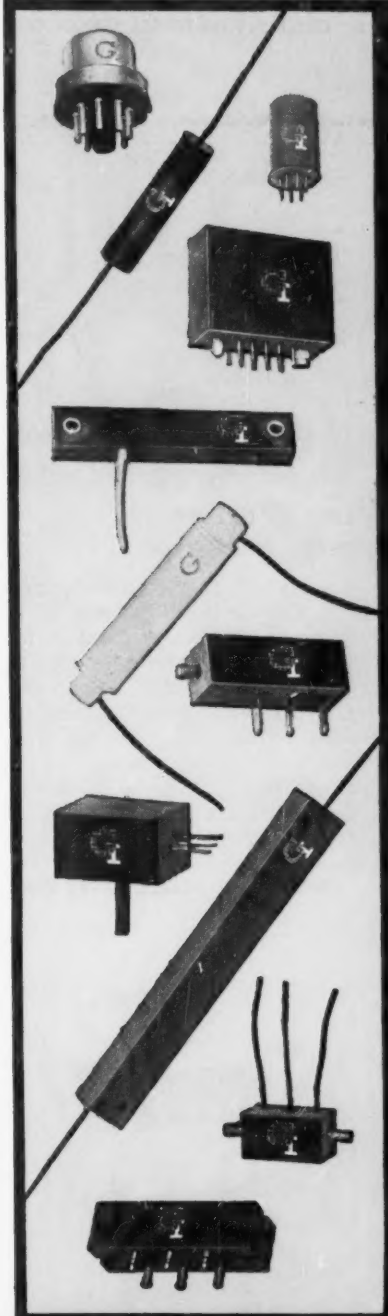

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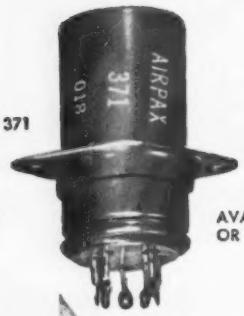


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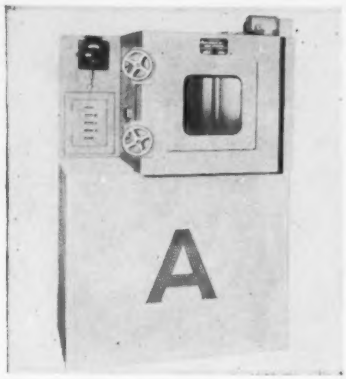


## Test Chamber
### temperature type

ASSOCIATED TESTING LABORATORIES, INC., Clinton Road, Caldwell, N. J. Environmental test chamber for low-high temperature testing at −100 F to +1,000 F. Liquid $CO_2$ will pull-down from ambient to −100 F in less than 3 minutes. Heat load dissipated in chamber is at least 5,000 BTU/hr at −100 F. Dimensions are 18 by 18 by 18 in. Price: $1,250, plus optional features.

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### portable units

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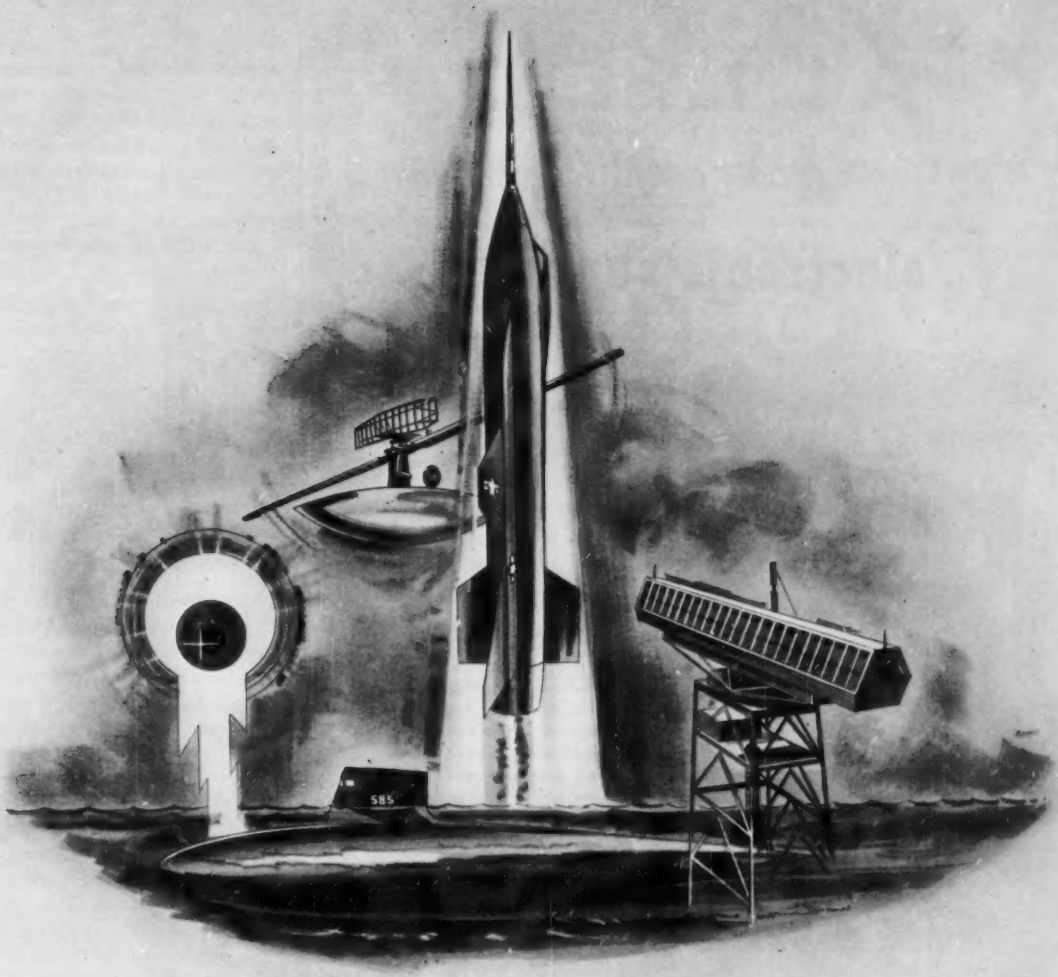

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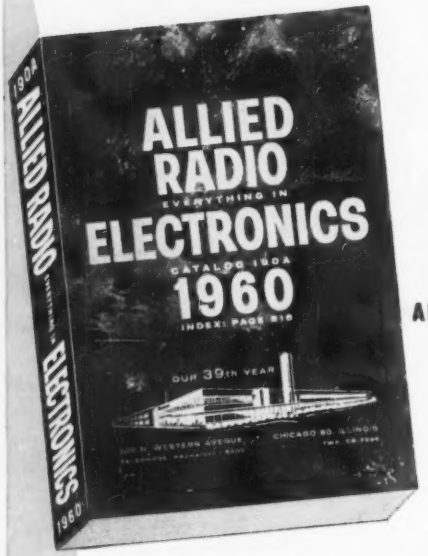


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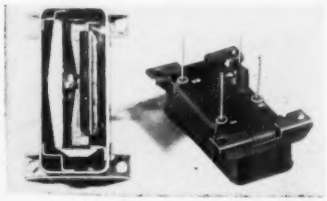

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**for missile use**

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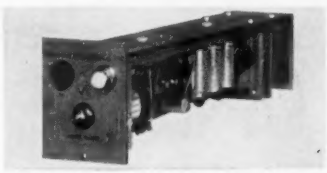

### D-C Power Supply
**solid-state**

VIDEO INSTRUMENTS CO., INC., 3002 Pennsylvania Ave., Santa Monica, Calif. Model SR-200E solid-state regulated supply with floating output is designed especially for strain gage excitation. It features less than 10 μv of noise peak to peak when measured with a 350 ohm strain gage bridge, 0.1 percent regulation for line voltage changes from 95 to 135 v, high insulation resistance to ground (at least 10,000 megohms), an extended voltage range from 0 to 15 v continu-

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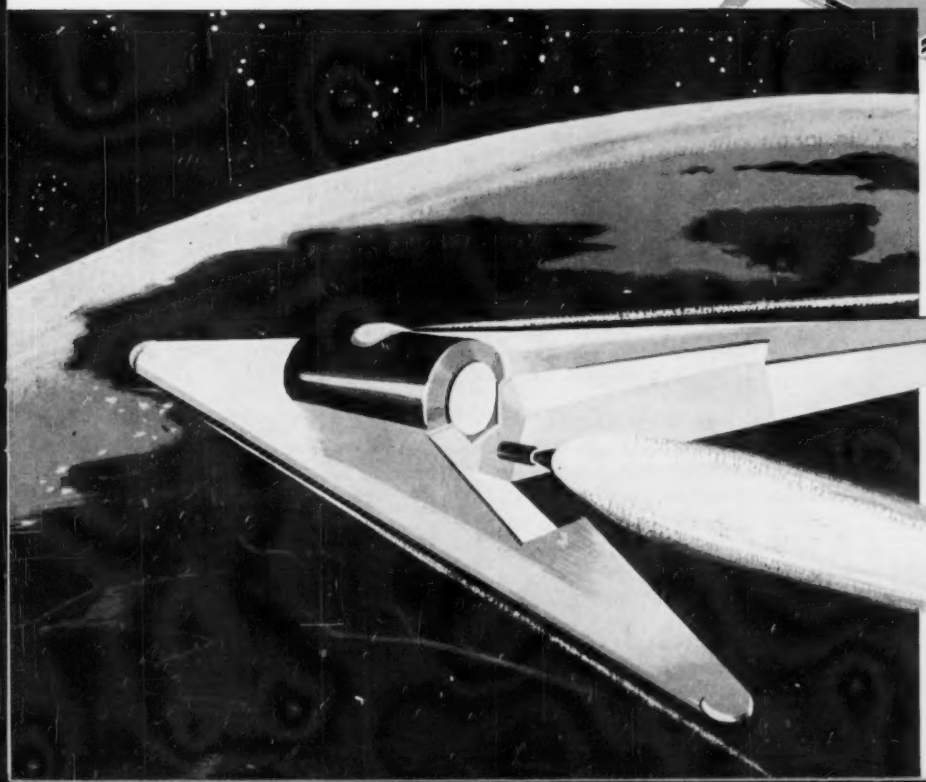

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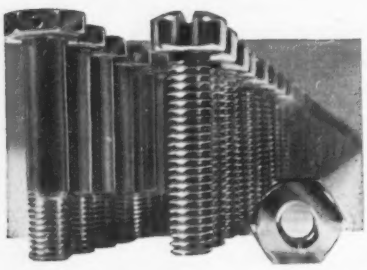

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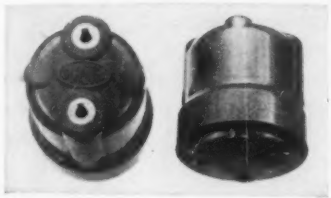

## Standoff Insulator
### 5 kv rating

THE GLASTIC CORP., 4321 Glenridge Road, Cleveland 21, Ohio. Glastic fiber glass reinforced polyester insulators have a proven performance record of several years service in a variety of large mill power control apparatus (5 kv rating), where they are functioning as bus supports and switch and contactor support insulators. They feature greater dimensional accuracy, greater impact strength, no chipping, less weight and lower cost.

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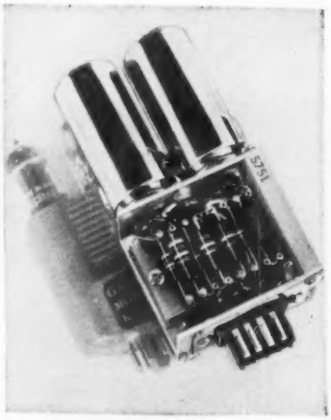

## D-C Amplifier
### operational type

GEORGE A. PHILBRICK RESEARCHES, INC., 285 Columbus Ave., Boston 16, Mass. Model K2-WJ plug-in d-c operational amplifier for high reliability military applications. It is similar to commercial version, but slightly smaller and has open frame construction for optimum ventilation and at higher ambient temperatures. Design center d-c

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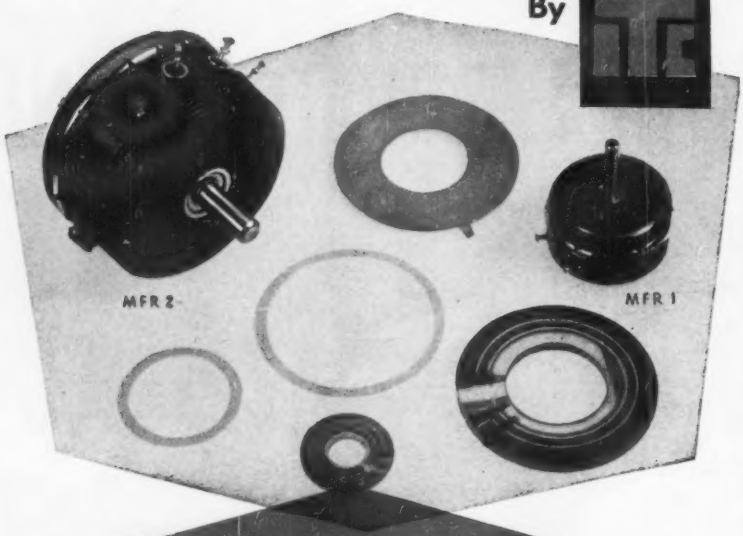


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open loop gain is 15,000; at 500 kc the open loop gain is typically greater than 2. Maximum design output range of ±50 v at 1 ma may be increased by booster follower techniques.

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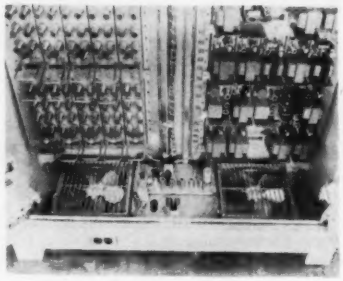
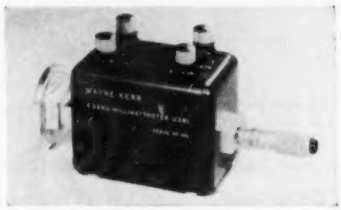


## Reversible Fans wide range of cfm's

McLEAN ENGINEERING LABORATORIES, P. O. Box 228, Princeton, N. J. Filter box propeller fans are shown cooling computer racks in an electronic flight simulator built by the Electronics Division of Curtiss-Wright Corp. The fans have a range of cfm's suited to trailers, vans, mobile or stationary generating systems and are adaptable to many mounting arrangements.

**CIRCLE 218 ON READER SERVICE CARD**



## Milliwattmeter for X-band

WAYNE KERR CORP., 2920 N. 4th St., Philadelphia 33, Pa., announces a portable and extremely accurate resistive film bolometer wattmeter, the X-band microwave milliwattmeter, type U-281, for the measurement of microwave power. It measures power in a 1 to 100 mw range with an accuracy of ±3 percent, over the frequency band 8.4 to 10.2 kmc. The unit consists of a thin resistive film which is mounted symmetrically in the transverse plane of the waveguide. The rise in temperature of this film caused

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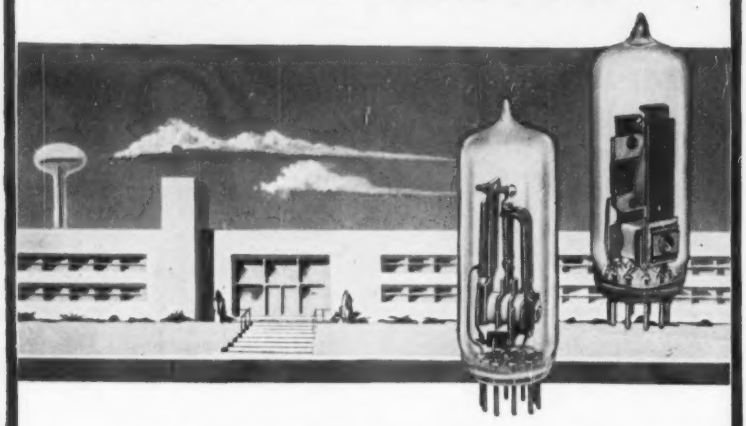

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SPECIFICATIONS

Time delay.....Preset 3 to 60 seconds
Contact arrangement.....SPST or SPDT
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Weight.....Less than one ounce
Base.....Miniature 9 pin
Size.....T6 ½ bulb—Max. hgt. 2⅜"

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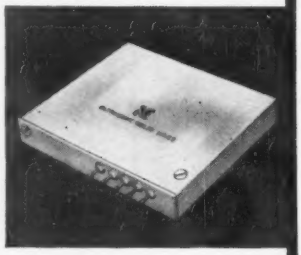

SPECIFICATIONS

Delay range.....5 to 6000 microseconds
Tolerance.....± 0.1 microsecond
Signal to noise ratio.....Greater than 10:1
Input and output impedance.50 to 2000 ohms
Carrier frequency.....100 kc – 1 mc
Delay to pulse rise time.....Up to 800:1

WRITE FOR COMPLETE COMPONENTS CATALOG 159

ELECTRONICS DIVISION

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by absorption of incident microwave radiation is used to measure the input power.

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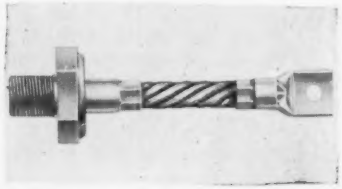

### Silicon Rectifier 50 to 400 piv

SARKES TARZIAN, INC., 415 N. College Ave., Bloomington, Ind. Y series have thermal drop less than 10 C junction to base, junction temperature rise of approximately 60 C, and are rated at 250 amperes d-c to minimize thermal-aging problems and extend life expectancy. Either positive or negative base polarity is available. Designed for use in welding, electroplating and electrolysis, or any application requiring 1,000 or more d-c amperes.

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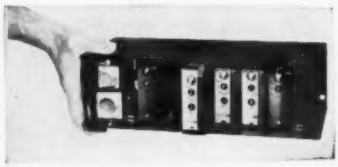

### Signal Conditioner for airborne use

NEFF INSTRUMENT CORP., 2211 E. Foothill Blvd., Pasadena, Calif. The SCAMP signal-conditioning system is designed specifically for airborne telemetry and tape applications, and features transistorized d-c, a-c, or carrier amplifiers. It accepts mv inputs and produces 0-5 v to drive voltage controlled oscillators or record amplifiers. The 6-channel modular case accepts any combination of solid-state amplifiers, each containing separate controls and capable of individual operation in or out of the case. Each amplifier measures 1¼ in. wide, 3⅞ in. high and 4⅞ in. long. Gain stability is better than 1 percent over all environmental conditions including 20 g's shock, vibration of 1 in. peak-to-peak from 5

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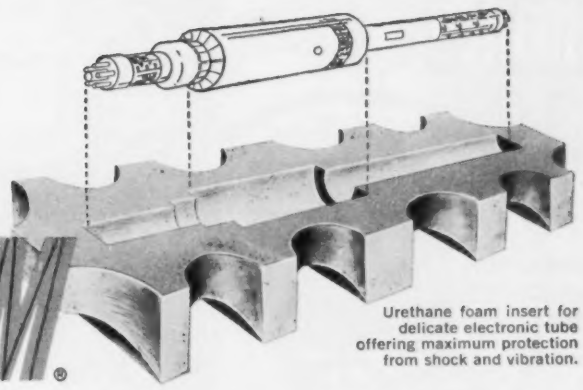

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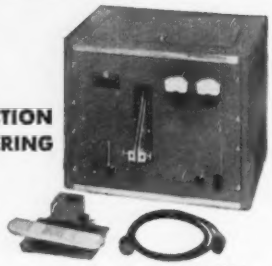

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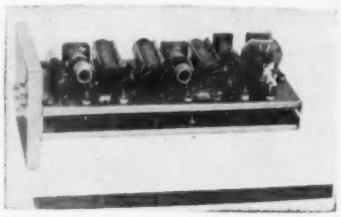

## VHF Beacon
### miniature type

LEL, INC., 380 Oak St., Copiague, N. Y. Miniature vhf beacon aircraft or drone crash locator, signaling, control, telemetering or other purposes is crystal-controlled. Three subminiature tubes supply carrier output up to 100 mw in 300 mc band. Contains transistorized modulator-power supply. Input is 6 v at 660 ma; output impedance, 50 ohms; modulation, 1,000 cycles.

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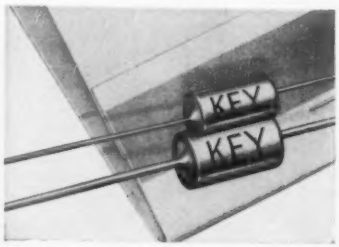


## Stable Resistor
### deposited-carbon

KEY RESISTOR CORP., 321 W. Redondo Beach Blvd., Gardena, Calif. Deposited-carbon resistors shown are filled with silicone oil and hermetically sealed for stability under heat and high voltage. Units meet all MIL specs; are available in all military sizes, plus ½ w and ⅒ w, in resistance values from 5 ohms to 20 megohms.

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## Ferrite Isolators
### for C-band use

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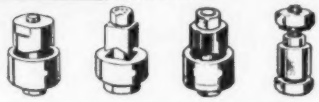

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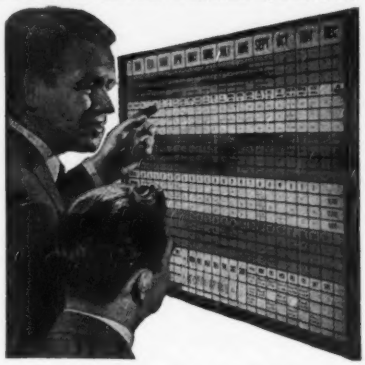

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# Meet John Mason

Associate Editor, **electronics**
**MILITARY ELECTRONICS EXPERT**

**Resumé:**

Mexico City College, Mexico, BA. Air Force officer, navigator with 32 combat missions; Director of Flight Training, Pathfinder Radar School; head of Loran School. News editor, associate editor of aeronautical trade magazine, wrote free lance aviation articles. Recalled to Air Force, 1951, and studied at Georgetown Graduate School. Assigned to Libya, then Munich. Wrote news stories plus daily digest of iron curtain radio news.

**Present Occupation:**

As an associate editor of **electronics** John is deeply involved with the technical and business aspects of military electronics (the current $4.5-billion government market) and draws heavily on his electronics and Air Force background.

**References:**

John is typical of the 26-man staff of specialists who edit **electronics** . . . men who produced 2,856 pages of editorial material during 1958. A mature, experienced staff, averaging 36 years of age, these people are dedicated to serving the needs of the reader of **electronics**. If your subscription to **electronics** is expiring, or if you are not a subscriber . . . if you will miss reading some of the exciting articles John Mason is planning for the near future . . . fill in the box on the Reader Service Card. It's easy to use. Postage is free.

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tory use in 6,575 to 6,875 mc C-band applications. Isolation loss is 40 db; insertion loss, 1.0 db; vswr, 1.2; nominal ambient temperature, 130 to 160 F; weight, 2 lb; length, 5 in.

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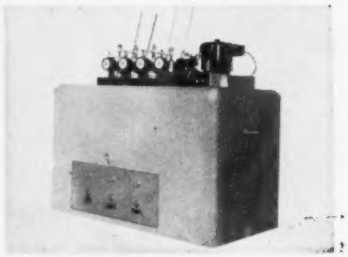

### Deflection Tester for plastics

AMERICAN INSTRUMENT CO., INC., 8030 Georgia Ave., Silver Spring, Md. Lab instrument indicates the deflection of thermoplastics when subjected to various loads and temperatures in accordance with ASTM test D648-56. As many as four samples can be tested simultaneously by placing each in a specimen holder and lowering the holders into an insulated bath. Deflections are indicated on dials mounted on the specimen holders. Unit measures 26 by 16½ by 23 in. high. Bath temperature can be increased at the rate of 2 C per minute from ambient to 260 C, or maintained constant at any point within this range.

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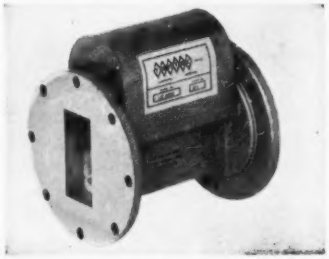

### C-Band Isolator high power

RANTEC CORP., Calabasas, Calif. Model IC-400 C-band load isolator covers 4.6-6.0 kmc band and provides 12 db minimum isolation (18 db band center) with 1.0 db maximum insertion loss (0.6 db band

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**MEET ROLLY CHAREST**

**RESUME:**

Charest, Roland J., Boston University, BS in Journalism. Formerly New England editor for **electronics.** Navy sonarman. Writer, reporter, editor for Lynn Item, Boston Globe, Boston Traveler. Won a New England Associated Press (AP) award in 1955 for writing feature articles in the major city newspaper class.

**PRESENT OCCUPATION:**

Rolly Charest supports Managing Editor Jack Carroll for editorial content accuracy and expediting putting each weekly issue to bed. Rolly reworks headlines for greater readability, is involved in makeup, and helps polish editorial content. Rolly's across-the-board background assures you accuracy in the face of journalistic pressures; articles in this week's issue that could be held over to the next deadline, but are not. The readers' interests come first!

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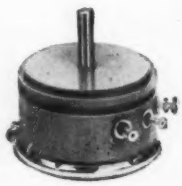

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center). It has been successfully tested at a power level of 300 kw peak, 300 w average, in the presence of an ionizing source with a 2:1 variable phase load impedance. Unit is constructed in UG49/U waveguide with UG-149A/U flanges; length 4 in., weight 4¾ lb.

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## Register Tube
### cold-cathode

BAIRD-ATOMIC, INC., 33 University Rd., Cambridge 38, Mass. Digitron cold-cathode register tube GR10G may be added to existing counter circuits to display the state of count of either hard-tube counting circuits or cold-cathode load tube decades. It is ideal for indicating the position of selector or stepping switches on a remote panel or monitor board. The 1½ in. high numerals may be read easily from distances up to 50 ft at a 160 deg angular readout in brighter than normal room illumination.

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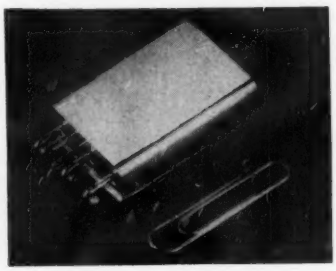

## Crystal Can Relay
### rugged construction

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| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
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| 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 |
| 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
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| 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 |
| 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 |
| 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 |

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| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 |
| 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 |
| 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 |
| 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 |
| 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 |

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In every industry there's always ONE accepted Product and Data Buying Book . . . in electronics it's the BUYERS' GUIDE — fundamental in any sales program aimed at the electronics and allied industries. Its 52,000 paid subscribers are important Design-Research/Production/Management Engineers, who, individually, or working in combination with one another, influence the purchase of products, materials and services . . . whatever is bought by the entire industry.

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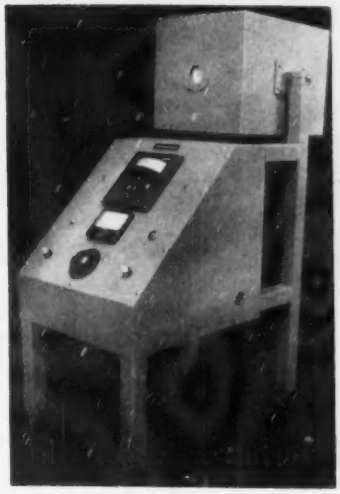
switching mechanism capable of handling 10 ampere loads for 100,000 operations. Operating power is 150 mw for 20 g to 2,000 cps vibration. Coil resistances are available to match any transistor or vacuum tube load.

**CIRCLE 228 ON READER SERVICE CARD**



## Laboratory Furnace multipurpose

MATERIALS RESEARCH CORP., 47 Buena Vista Ave., Yonkers, N. Y. Model MF-90 multipurpose furnace provides a heat treating and experimental laboratory furnace in one apparatus. It may be used in horizontal or vertical position at temperatures up to 1,100 C. A clock motor is mounted for use in the growth of single crystals by the Bridgman technique. An immediately replaceable furnace core avoids lengthy shut down.

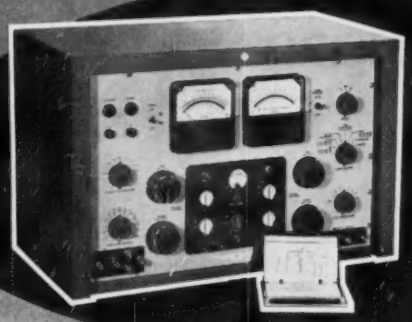
**CIRCLE 229 ON READER SERVICE CARD**

## Energy Storage System nuclear-battery power

RADIATION RESEARCH CORP., 1114 First Ave., New York 21, N. Y. Energy storage systems capable of storage densities exceeding 10 million ergs/cu. in. utilizes nuclear battery with a specially designed low leakage, high voltage, storage capacitor and voltage regulator tube for applications requiring constant available energy over long periods of time. The nuclear bat-


from

Instrument Calibration HEADQUARTERS



The proven method of maintaining Accuracy

*Improved reliability and sustained quality control, through periodic calibration of test instruments, can be achieved by semi-skilled personnel using either of these self-contained standards.*

Model 829 provides full-scale calibration accuracy of 0.5% for both AC and DC meters over ranges from 0.25 millivolt to 2000 volts and 2 microamperes to 20 amperes. AC calibrations can be performed from 50 to 400 cps., depending on line frequency used, or unit can be driven by optioned variable frequency power supply. Automatic protection for both operator and instrument under test is provided by interlocks and high voltage discharge circuits. Net price $2,650.

Model 829A provides full-scale calibration accuracy of 0.25% for AC and DC meters over same ranges as Model 829. Horizontally mounted standard meters are employed, and a fluorescent light is provided for proper illumination. The illustration shows the Model 829A mounted on the Model 10 Test Equipment Cart with the standard meters recessed into a drop-leaf work shelf. Mounted inside the Cart is the Model 500 Variable Frequency Power Supply which will supply any frequency for calibration from 50 to 400 cps., plus excellent line regulation. Net price of Model 829A with special Weston meters is $3,150.

*Performance is rigidly guaranteed. Prices are f.o.b. Boonton, N.J. and subject to change without notice.*

SEND FOR TECH. DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

RFL Radio Frequency LABORATORIES, INC. Boonton, New Jersey, U.S.A.

MASSA

# METERITE

THE FIRST
MODULAR
*2 Channel*
PORTABLE RECORDING SYSTEM

MASSA METERITE
Model BSA 200
Basic System Assembly
with Preamplifiers

*Outstanding Features*

- INTERCHANGEABLE PLUG-IN PREAMPLIFIERS — Low, Medium, High Gain DC; AC; Chopper; Carrier and Servo
- EXTENDED FREQUENCY RANGE — Full Scale Amplitude to 100 cps. Reduced Amplitudes to 200 cps available
- RECTILINEAR MOTION — Free of Curvilinear Distortion
- 6 CHART SPEEDS — Covering the Range .5 to 200 mm/sec
- INK OR ELECTRIC WRITING — Ink, using hermetically sealed disposable ink cartridges. Electric, using auxiliary power supply and electric styli
- TRANSISTORIZED DRIVER AMPLIFIERS — Differential and Single Ended
- LIGHTWEIGHT — Approximately 35 lbs.

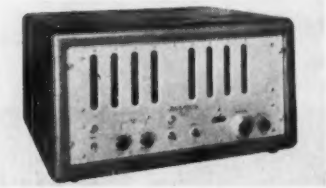
*Multi-Channel Systems Are Also Available*
*Write for Complete Information*

MASSA
A DIVISION OF
COHU
ELECTRONICS, INC.
6 FOTTLER ROAD
HINGHAM, MASSACHUSETTS

CIRCLE 118 ON READER SERVICE CARD

tery uses Krypton 85 and is free from the hazards of ingested radioactivity.

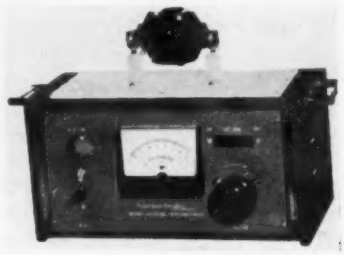
CIRCLE 230 ON READER SERVICE CARD



## Scaler
## count and time

RADIATION INSTRUMENT DEVELOPMENT LABORATORY, INC., 5737 S. Halsted St., Chicago 21, Ill. Model 49-33 combines decimal count scaler with time scaler on single chassis. It features preset time to 1,000 sec or preset count to $10^7$; resolving time, 1 $\mu$sec; positive or negative input; includes full range discriminator, precision fixed mercury pulse generator and electrically reset four digit register.

CIRCLE 231 ON READER SERVICE CARD



## Portable Tester
## of insulating oil

ASSOCIATED RESEARCH INC., 3777 W. Belmont Ave., Chicago 18, Ill. Model 4505-A is a portable high voltage tester of insulating oils used in oil immersed transformers, bushings, power supplies, electronic components and assemblies. It weighs 42 lb and provides up to 35 kv a-c at 2 kva for voltage breakdown tests. Price is $725.

CIRCLE 232 ON READER SERVICE CARD

## Thyratron Tube
## high-voltage

WESTINGHOUSE ELECTRIC CORP., P. O. Box 284, Elmira, N. Y. WL-

# THE GUIDE TO INDUSTRIAL ELECTRONIC WIRE & CABLE

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NEW INDUSTRIAL EDITION

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# Engineered...
## DRAWN SHELLS
## FORMED METAL PARTS

EYELETS • FERRULES • METAL STAMPINGS • ASSEMBLIES

**ENGINEERING** The Cly-Del Engineering Department is available to you to help develop your requirements.

**TOOL ROOM** The Cly-Del Tool Room can help you meet the demands of time, economy, accuracy.

**MANUFACTURING** Cly-Del . . . The complete home for contract production . . . can manufacture custom parts for you from all metals.

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46 SHARON ROAD
WATERBURY, CONN.

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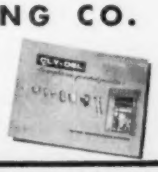
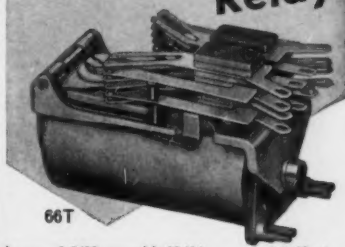
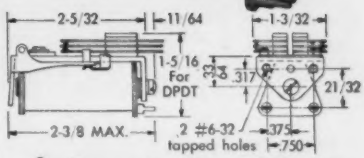


CIRCLE 163 ON READER SERVICE CARD

# New 66 Magnecraft Relay




## of Great Sensitivity

| Minimum Operate Milliwatts | | | |
|---|---|---|---|
| SPDT | DPDT | 3PDT | 4PDT |
| 60 | 120 | 200 | 300 |

## Long Time Delay

**Operate Delay up to .15 sec.**
**Release Delay up to .25 sec.**

## and Tremendous Life

***A unique, pin-type armature hinge, with stainless steel pin and heavy duty yoke with precision reamed over sized bearing surfaces assures reliable operation through long service with minimum adjustment.***

Available with wide selection of contacts ranging from ***bifurcated*** gold alloy for dry circuits to 10 ampere heavy duty.

For DC operation with 12 contact arms per stack (24 arms per relay).

For direct AC operation with 6 contact arms per stack (12 arms per relay).

Full wave rectified for operation from all AC frequencies (25 to 400 cycles) with 12 contact arms per stack (12 arms per relay).

Also available with plug-in mounting and hermetically sealed or dust tight enclosure.

Can be furnished to meet military specifications for shock and vibration; also to withstand wide temperature variations.

***Literature mailed promptly on request.***

**MAGNECRAFT**
Electric Company
3350B W. Grand, Chicago 51, Ill.

CIRCLE 119 ON READER SERVICE CARD

## New UNION readout instruments withstand shock, vibration and extreme temperature changes

Union Switch & Signal's new READALL* readout instrument replaces complicated systems of lights and relays for reading, storing or transferring all types of information for industrial and military applications. It is not to be confused with conventional indicating devices.

**Designed to meet requirements of MIL-E-5422D.** The new READALL readout instrument is precision-built and provides instantaneous and continuous operation under conditions of shock, vibration and extreme ranges in temperature. The digital display includes characters in numerical sequence from 0 to 9 plus two blank spaces. 7/32-inch characters can be illuminated red or white as desired; when not illuminated, they appear white against a black background.

**Reliability.** Performance through one million random operations is an inherent feature of the new READALL instrument. Each module is gasket-sealed in its case to exclude moisture and seal out foreign particles. An especially thin enclosed DC motor, containing ball bearings, permits more efficient operation.

**Modular Construction.** A unique feature of the readout instrument is its modular construction. It can be used individually or in groups to display multiple characters in a single case.

**Direct Code Translation.** The operation of the READALL readout instrument is based on a positioning system using a four-bit code. The visual display is the result of a direct electro-mechanical conversion of a binary signal to a decimal read-out. There is no need for additional conversion equipment. Separate code and motor circuits permit the use of the readout instrument in low-level circuitry.

**Electrical and Visual Data Storage.** Once positioned, the information is displayed until a new code is transmitted to the instrument. No power is consumed while the information is retained. This data may be stored or read-out electrically for further transmission or recording.

**Operate Time.** The operate time varies from 0.1 second to 1.0 second depending on character position.

**Weight and Size.** Maximum weight including case is seven ounces; without case, four and one-half ounces. Size encased is 5 13/64 inches long, 1 47/64 inches high and 31/64 inch wide. The new READALL instrument is designed for operation over a temperature range of −54°C to +71°C in humidities up to 100% and altitudes up to 70,000 feet. For more information, write for Bulletin 1019.

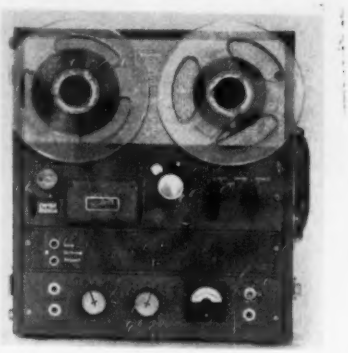
*Trademark

*"Pioneers in Push-Button Science"*

UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18, PENNSYLVANIA

7269 high-voltage thyratron tube for new designs of d-c power supplies. Rating of 3.2 amperes and 21-kv inverse voltage permits design of 20-kv, 10-ampere, three-phase, full-wave bridge-type rectifier adjusted by phase control from zero to full voltage. Also permits high-speed electronic regulation of the d-c output.

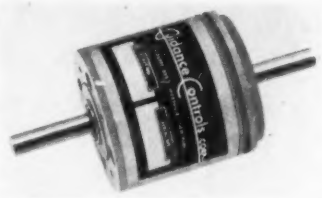
**CIRCLE 233 ON READER SERVICE CARD**



## Tape Recorder full track

ROBERTS ELECTRONICS INC., 1028 N. LaBrea Ave., Los Angeles 38, Calif. Model 191 full track monaural tape recorder (similar to 90-C stereo recorder) with new full-track erase and record/playback heads. Equipped with head, preamp, amplifier outputs, Roberts hysteresis synchronous motor and VU meter. Price: $325.

**CIRCLE 234 ON READER SERVICE CARD**



## Magnetic Clutch meets MIL-E-5272B

GUIDANCE CONTROLS CORP., 110 Duffy Ave., Hicksville, L. I., N. Y. Type C-18 magnetic clutch features high output torque for its size. For friction face models output torque is 80 oz in. (minimum) at 24 to 28 v d-c. Breakaway torque is 0.15 oz in. energized and 0.05 oz in. de-energized. Maximum weight is 13.5

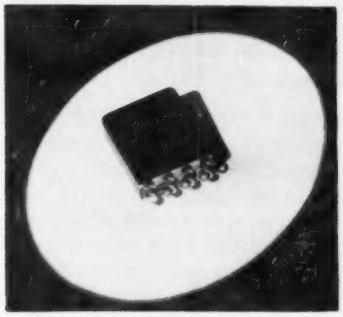
oz. It meets MIL-E-5272B environmental qualifications tests for vibration, fungus, shock, humidity, temperature, salt spray, sand and dust.

**CIRCLE 235 ON READER SERVICE CARD**

## Motor Drive Amplifier precision unit

PRECISION INSTRUMENT CO., San Carlos, Calif. Designed to provide precise 60 cps power for tape recorder motors, the MDA series has applications in other fields where extreme frequency regulation of the power source is required. Motor drive amplifiers are available for operation from either 24-28 v d-c or 105-125 v a-c, 48-62 cps. Output is 100 w with frequency regulation ±0.02 percent. Third harmonic component is negligible. Unit weighs 35 lb, measures 7½ in. high by 15½ in. wide by 8⅝ in. deep. Price is $1,350.

**CIRCLE 236 ON READER SERVICE CARD**



## Crystal Case Relay rugged unit

HI-G, INC., Bradley Field, Windsor Locks, Conn. Type B relay meets all requirements of MIL-Std drawing MS-24250. Also available as type BR, with internally mounted silicon rectifiers for use at 400 cps a-c or higher. Contact rating is 2 amperes at 28 v d-c or 115 v a-c for a life of 100,000 cycles. Both types


# F.M. Deviation Measurement

## *Wide Deviation — High Carrier Frequency*

**MARCONI DEVIATION METER MODEL 928 CAN BE USED AT CARRIER FREQUENCIES UP TO 500 mc FOR DIRECT MEASUREMENT OF DEVIATIONS UP TO 400 kc.**

**DEVIATION METER MODEL 928/2**

is an alternative narrow-deviation model arranged for use at carrier frequencies between 215 and 265 mc.

*Please send for leaflet B132/A*

**ABRIDGED SPECIFICATIONS** *928:* — CARRIER FREQUENCY: 20-100 mc (fundamental), up to 500 mc using harmonics. FREQUENCY DEVIATION: 0-100 kc, 0-200 kc; 0-400 kc in the mod. frequency range 50 cps—120 kc. ACCURACY: ±3% R.F. INPUT RANGE: 55 mv—10 v. *928/2:* — As above except for the following:—CARRIER FREQUENCY: 215—265 mc. FREQUENCY DEVIATION: 0-15 kc, 0-50 kc, 0-150 kc.

**MARCONI INSTRUMENTS**

*Marconi for f m test gear*

**111 CEDAR LANE ENGLEWOOD NEW JERSEY Tel: LOwell 7-0607**
Canada: Candian Marconi Co. Marconi Building, 2442 Trenton Ave. Montreal 16
**MARCONI INSTRUMENTS LTD · ST. ALBANS · HERTS · ENGLAND**

TC132R

**PYRISTOR**® *...protects your equipment circuitry...precisely*

NEW miniature, hermetically sealed, single-shot, current-sensitive switch for positive overload protection and for current operated triggering devices.

RELIABILITY *in critical environments*
...from −100° F. to +1000°F. continuous.
...closing time 1 millisecond to 5 seconds.

*Write for new Brochure containing complete specifications:*
advanced concepts of precision specialty switches for maximum protection

thermocal
1631 COLORADO AVENUE
SANTA MONICA, CALIFORNIA

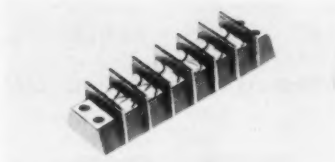
are suitable for vibration of 30 g to 2,000 cps minimum, and employ permanent magnets as "hold open" devices to eliminate contact chatter due to mechanical resonance.

**CIRCLE 237 ON READER SERVICE CARD**

## Panel Meter subminiature

ALCO ELECTRONICS MFG. CO., 3 Wolcott Ave., Lawrence, Mass. Model S-10 subminiature ½-in. panel meter has shielded moving coil movement and adapts to miniature transistorized circuits for voltage and current indication. Unit's clear plastic front measures ⅝ by ⅝ in., ½-in. barrel diameter. Available ranges are 0-200, 500 μa d-c; 0-1, 5, 10 and 20 ma d-c; 0-15, 0-100 v d-c; and 0.150 v a-c.

**CIRCLE 238 ON READER SERVICE CARD**



## Terminal Boards commercial type

GENERAL PRODUCTS CORP., Union Springs, N. Y. Terminal boards for commercial applications have molded-in conductors, do not need saddle plates on mounting supports. Solid insulating back reduces breakage, guards against moisture and makes insulating strip unnecessary. Interchangeable with other industrial boards, they feature current carrying capacity, long creepage path, and thick, high barriers for insulation.

**CIRCLE 239 ON READER SERVICE CARD**

## Control Chassis stores encoder data

DATEX CORP., 1307 S. Myrtle Ave., Monrovia, Calif. Model K-111 con-

IN PARIS
FROM FEBRUARY
19th. to 23rd.
1960

# the 3rd international exhibition of electronic components

All manufacturers throughout the world will be showing their latest achievements.

Apply for your exhibitor's file NOW. It will give you all the information you need in connection with your participation.

FÉDÉRATION NATIONALE DES INDUSTRIES ÉLECTRONIQUES

23, rue de Lübeck - PARIS 16e - Tél. : PAS. 01-16

CIRCLE 164 ON READER SERVICE CARD

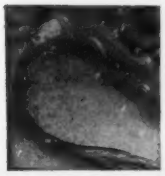
*NOW POSSIBLE...*

*instant construction of Shielded cables with*

## NEW! SHIELDED AUTHENTIC Zippertubing

**FEATURES:**

- Pure metal foil now laminated to the inner surface of Zippertubing for immediate shielded cable.
- Shielded cable at a fraction of the cost of the conventional tin-copper shielding, plus outer jacket.
- Permits emergency and maintenance repair modifications in the field.
- Both high & low frequencies are shielded up to six gausses with attenuation result up to 1200:1 at 250MC.
- Offered with overlap construction for 100% coverage protection.
- May be stored in flat form with sizes from ½" I.D. up.



A strong, durable, yet flexible shielded cover can be applied in minutes. With Shielded Zippertubing a manufacturer can create his own shielded cable at a fraction of the cost and approximately 1/10 of the delivery time. The normal time and labor spent in encasing cables and wire harnesses can be reduced by as much as 90%. No special equipment necessary.

Three ranges of shielding available; light-aluminum, medium-lead, heavy duty-magnetic foil.

**SPECIFICATIONS:**

**Wall Thickness:**
.020, .040, .060 AWG

**Material:**
Plastic saturated fiber glass backed material laminated to various metal foils.

**Put-Up:**
Available in 25 to 300 foot rolls. Longer lengths available upon specification.

**Sizes:**
¾" I.D. up, in increments of ⅛", ± ¼".

**Colors:**
Gray. Other colors available on special order.

Zippertubing MANUFACTURED BY
THE ZIPPERTUBING CO.
752 So. San Pedro Street, Los Angeles 14, Calif., Michigan 0831

CIRCLE 165 ON READER SERVICE CARD

## IN LESS THAN 4 SECONDS

FROM THIS
TO THIS
OR THIS

WITH THE REVOLUTIONARY PRODUCTION AID TOOL!

**"PIG-TAILOR"®**

*Foot operated*
*No accessories*
*3 minute set up*

**$125.00**

**"PIG-TAILORING"**

**a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.**

***PIG-TAILORING eliminates:*** • Diagonal cutters • Long nose pliers • Operator judgment • 90% operator training time • Broken components • Broken leads • Short circuits from clippings • 65% chassis handling • Excessive lead tautness • Haphazard assembly methods.

***PIG-TAILORING provides:*** • Uniform component position • Uniform marking exposure • Miniaturization spacing control • "S" leads for terminals • "U" leads for printed circuits • Individual cut and bend lengths • Better time/rate analysis • Closer cost control • Invaluable labor saving • Immediate cost recovery.

***Pays for itself in 2 weeks***

**"SPIN-PIN"®**

Close-up views of "SPIN-PIN" illustrate fast assembly of tailored-lead wire to terminal.

- No Training
- No Pliers
- No Clippings
- Uniform Crimps
- 22 Sizes

**PAYS FOR ITSELF THE FIRST DAY!**

**$5.00** EACH

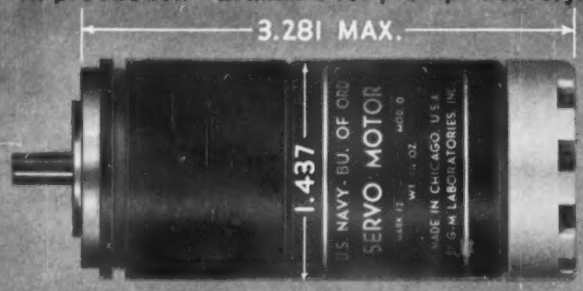
*Write for illustrated book to Dept E-10*

BRUNO-NEW YORK INDUSTRIES CORP.
DESIGNERS & MANUFACTURERS OF ELECTRONIC EQUIPMENT
460 WEST 34th STREET • NEW YORK 1, N. Y.

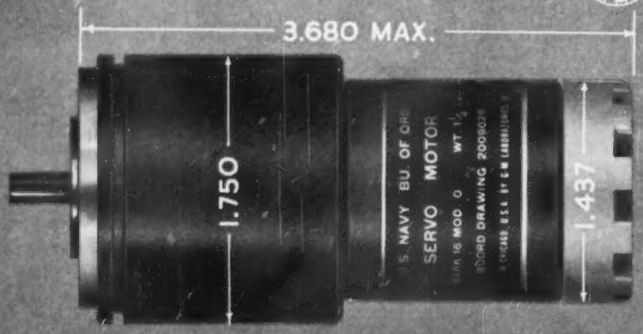
CIRCLE 123 ON READER SERVICE CARD

# GM TACHOMETER-GENERATORS

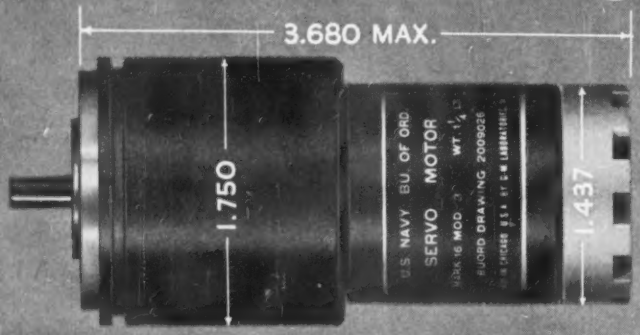
Built to all applicable Government Specifications.
**In production—available for prompt delivery.**




**BuOrd Mark 12 Mod 0** SERVO MOTOR Tachometer Generator 115 volts / phase, 4500 RPM (min).




**BuOrd Mark 16 Mod 0** SERVO MOTOR Tachometer Generator 115 volts / phase, 4500 RPM (min).




**BuOrd Mark 16 Mod 3** SERVO MOTOR Tachometer Generator for transistor operation 115 volts fixed phase 36/18 volts control phase, 4500 RPM (min.)

GM
**G-M Servo Motors**
manufactured by the Components division of
G-M LABORATORIES INC.
4336 N. Knox Avenue • Chicago 41

For complete information on these and all SERVO MOTORS, write for G-M PROCUREMENT SPECIFICATION NO. 865 and Catalogue

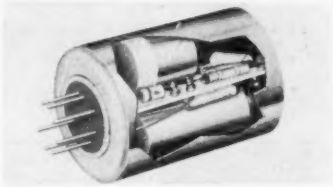

trol chassis offers rapid acquisition of data. Unit translates Datex or other binary-coded inputs into decimal or binary-coded outputs, and upon command stores the input information for remote readout. It utilizes transistor storage of encoder data and combines this buffer storage input with relay output. It is capable of three modes of operation: store only, follow only, or follow and store on command.

**CIRCLE 240 ON READER SERVICE CARD**

## Resistor very low noise

OHIO SEMICONDUCTORS, INC., 1035 W. Third Ave., Columbus 8, Ohio. Type MS-41 Magnetoresistor is a semiconductor in which electrical resistance is a function of an applied magnetic field. It features a 10 to 1 change in resistance with an applied field of 10 kilogauss. Greater changes can be achieved at greater fields with a linear dependency. At lower field densities, it obeys an approximate square function.

**CIRCLE 241 ON READER SERVICE CARD**

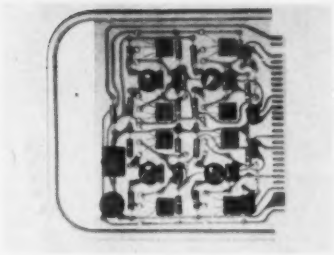


## Voltage Reference highly stable

NETWORKS ELECTRONIC CORP., 14806 Oxnard St., Van Nuys, Calif. Voltage reference has 1-v d-c output operating into 1,000 ohms. Output is held within ±1.2 mv over input conditions from 100 to 130 v a-c, 25 cps to 10,000 cps, operating temperatures of −55 C to +100 C, and any combination of specified

variations in temperature and power input. Meets MIL-E-5272A, requires 3 va nominal power, weighs 3 oz and mounts in any position. Used in power supplies, metering circuits, and strip chart recorders.

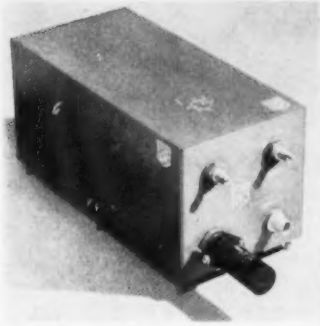
**CIRCLE 242 ON READER SERVICE CARD**



## Thyratron Driver
## 3.9 K output impedance

COMPUTER CONTROL CO., INC., 92 Broad St., Wellesley 57, Mass. Model TO-10 thyratron driver accepts standard T-PAC model LE-10 signals. Generates output pulses of sufficient amplitude and width to trigger thyratrons, other devices or circuits which cannot be driven directly from the LE-10. Output amplitude is 14.0 v positive; output pulse duration; 50 $\mu$sec minimum, 75.0 $\mu$sec nominal.

**CIRCLE 243 ON READER SERVICE CARD**



## Dual Delay Line
## relay operated

ESC CORP., 534 Bergen Blvd., Palisades Park, N. J. Model 71-50 is a relay operated, dual channel delay line, designed to obtain coincidence between two signals of different time and a third reference signal. Characteristics are: delay, 1 to 1.5 $\mu$sec, independently variable in each channel in increments of 0.05 $\mu$sec;


NEW FROM SPECTROL

*The Industry's First Complete Line of*

# METAL

## Multi-Turn Precision Potentiometers

Spectrol's sturdy new metal multi-turns are as tough to push out of shape as Sir Spectrol, our man in armor. Available in eight models, featuring anodized aluminum cases with 3/16 inch thick walls that absorb no moisture – dissipate more heat faster and stay dimensionally stable. These armored pots, four 3-turn and four 10-turn, will operate from −55°C to +125°C and withstand relative humidity of 95%.

You can choose diameters of 7/8, 1, 1-5/16 and 1-13/16 inches in both three and 10-turn models. Standard linearity tolerance is ±0.25% with special linearity available to ±0.020%. Like Sir Spectrol, the man in the iron suit, the new metal multi-turns will take a respectable jolt. They function to 20g vibration from 55 to 2,000 cps and withstand 30g shocks.

For more details, call you Spectrol engineering representative listed in the yellow pages or write us direct. Please address Dept. 180.

| MODEL | 540 | 530 | 580 | 560 | 780 | 790 | 880 | 840 |
|---|---|---|---|---|---|---|---|---|
| No. of coil turns | 10 | 3 | 10 | 3 | 10 | 3 | 10 | 3 |
| Diameter (inches max.) | ⅞ | ⅞ | 1 | 1 | 1 5/16 | 1 5/16 | 1 13/16 | 1 13/16 |
| Standard resistance range in ohms (±3%) | 25-125K | 10-36K | 25-150K | 10-40K | 30-300K | 10-90K | 50-400K | 20-120K |
| Special resistance to | 250K | 75K | 250K | 75K | 750K | 240K | 1 meg | 330K |

SPECTROL ELECTRONICS CORPORATION
1704 South Del Mar Avenue
San Gabriel, California

*Be sure your pot's in armor!*

13

**CIRCLE 125 ON READER SERVICE CARD**

# ....a "MUST" .....

## ANOTHER ACME ISONEL WIRE!

*Specify #175—Class F—155° C*

ACME Isonel Wire #175, when used with compatible varnishes, is suitable for Class F applications.

ACME Isonel Wire #175 has all the properties of Formvar Wire PLUS, without increase in cost.

ACME Isonel Wire #175, when used with ACME #150 Varnish, is suitable for Class B applications.

**THE ACME WIRE COMPANY**
NEW HAVEN, CONN.
MAGNET WIRE • COILS • VARNISHED INSULATIONS
INSULATING VARNISHES AND COMPOUNDS

CIRCLE 166 ON READER SERVICE CARD

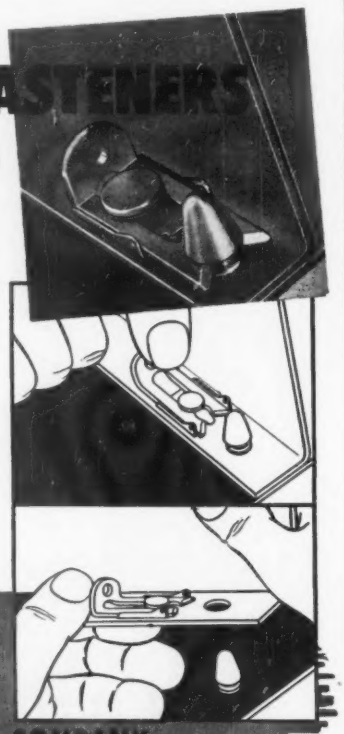
**DIMCO-GRAY SNAPSLIDE FASTENERS**

***PROVIDE VIBRATION-PROOF HOLDING AND QUICK, FOOL-PROOF RELEASE!***

APPROVED UNDER ARMY-NAVY STANDARDS

Here's a simple, easy means of securely fastening assemblies to withstand shock or vibration, *and yet allow quick removal for inspection or repair.* Instant snap action engages or releases fastener . . . no tools are required! After installation, fasteners never need adjustment . . . even with repeated use.

Three sizes available for different load requirements. Large and medium sizes are made of corrosion-resistant *stainless steel.* Small size is made of nickel-plated brass. Stock parts fit various thicknesses of flanges and mounting plates . . . special parts can also be supplied.

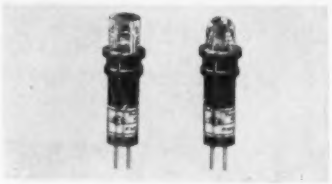


WRITE FOR FULL DETAILS TODAY!

**DIMCO-GRAY COMPANY**
202 E. SIXTH STREET DAYTON, OHIO


impedance, 1,000 ohms; output rise-time, 0.06 μsec per channel; dimensions, 8 by 4 by 4 in.

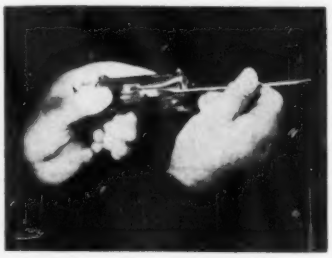
CIRCLE 244 ON READER SERVICE CARD



### Panel Light
### front mounted

TRANSISTOR ELECTRONICS CORP., 3357 Republic Ave., Minneapolis 26, Minn. FML series requires no rear in place by the lens which acts as a compression ring. Replacement is accomplished by removing the lens and slipping the unit forward through its own mounting hole. Connections are made by means of collet terminals, by wire wrap or by soldering. The FML mounts in a $\frac{3}{8}$ in. hole on $\frac{1}{2}$ in. centers.

CIRCLE 245 ON READER SERVICE CARD



### Spatula
### for relay cleaning

JONARD INTERNATIONAL CORP., 624 Madison Ave., New York, N. Y. Diacrom spatula cleans and polishes relays and contacts with diamond particles without affecting normal gap between contact points.

CIRCLE 246 ON READER SERVICE CARD

### Molding Compound
### polyurethane

COAST PRO-SEAL & MFG. CO., 2235 Beverly Blvd., Los Angeles 57, Calif. Pro-Seal 793 two-part polyurethane molding compound with

electrical properties and fluid resistance needed for cable. Temperature range is −65 F to +300 F; tensile strength, 2,000 psi; elongation, 500 percent. Aside from cable molding, the compound is used for general purpose molding, encapsulation and coating. Cures at room temperature.

**CIRCLE 247 ON READER SERVICE CARD**

## R-F Receptacle for printed wiring

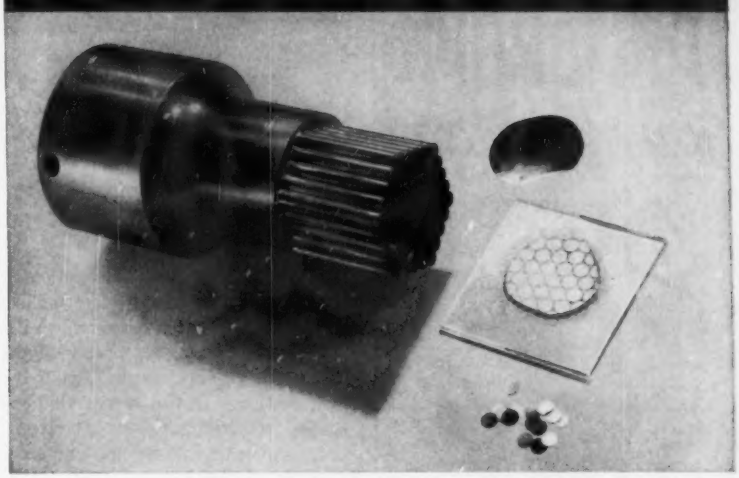
SEALECTRO CORP., 610 Fayette Ave., Mamaroneck, N. Y. A ConHex type 3007 receptacle connects coax cable to printed wiring by dip soldering. Center contact is held in assembly between two insulators, preventing longitudinal or rotating movement, and is also soldered to the printed wiring on the face of the board. Mates with ConHex type 3000 straight plug, type 3005 right-angle plug or equivalent.

**CIRCLE 248 ON READER SERVICE CARD**

## Test Set frequency-voltage

AIRPAX ELECTRONICS INC., Seminole Division, Ft. Lauderdale, Fla. Model 4B measures frequency, a-c and d-c voltages. Expanded-scale frequency meter (350 to 450 cps) accuracy is ½ cycle at 400 cps. D-C voltage measurement (0 to 30 v) accuracy is ½ percent at 27.5 v. Two a-c ranges (0 to 150 and 0 to 300 v) provide 1 percent accuracy at 115


# FREE ANALYSIS
## OF YOUR DIFFICULT MACHINING PROBLEMS



### Cuts Round Semiconductor Chips, Increases Yield 13%

**PROBLEM:** Cut round semiconductor chips from silicon and germanium wafers. Advantage of round chips is that for a given area they fit into smaller packages than rectangular chips. Also, round chips offer no orientation problem in packaging, thus lend themselves readily to automatic assembly.

**SOLUTION:** A **Raytheon Impact Grinding Analyst** recommended using ganged steel tubes brazed together as the cutting tool with a 700 watt Raytheon Impact Grinder.

**RESULT:** Round chips successfully mass-produced, yield per wafer of semiconductor material increased 13%.

**HOW YOU CAN BENEFIT:** Whatever your difficult cutting, slicing, drilling or shaping problem—in hard or brittle material your Raytheon Impact Grinding Analyst can help you solve it. For full details, fill out the enclosed coupon and send it in. No cost or obligation.

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**MAIL THIS COUPON FOR FREE ANALYSIS —without cost or obligation.**

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INDUSTRIAL APPARATUS DIVISION
PRODUCTION APPARATUS DEPT. GE10
MANCHESTER, NEW HAMPSHIRE

☐ Please send me literature on Raytheon Impact Grinders.

☐ Please have a Raytheon Impact Grinding Analyst contact me.

My problem is: (describe metals or non-metals involved, tolerances, etc.)

_____

_____

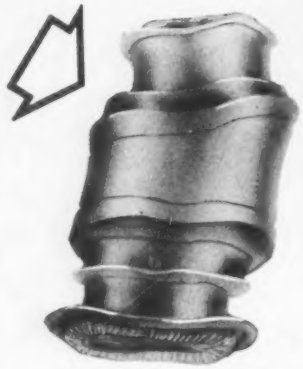
NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

# YOKE DISTORTION *your problem?*



**Uniform magnetic fields Produced in Celco Precision Deflection Yokes Minimize SPOT DISTORTION**

Exclusive **Celco** core materials make it possible to achieve faster recovery times, minimum hysteresis, high linearities and maximum sensitivities.

Contact **Celco** Engineering Department for a fast solution to all your yoke problems.

**Celco** produces a complete line of standard or special commercial and military precision deflection yokes.

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**Main Plant: MAHWAH, N. J. DAvis 7-1123**
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- Central Division, Lanesboro, Pa. - ULysses 3-3500
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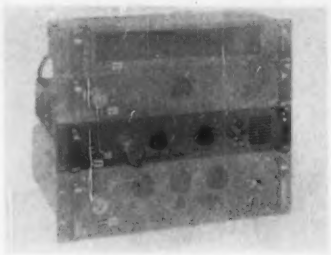
and 208 v, and 2 percent full-scale. Phase checker and continuity checking are built in.

**CIRCLE 249 ON READER SERVICE CARD**



## Preamplifier variable bandwidth

KIN TEL DIVISION of Cohu Electronics, Inc., 5725 Kearny Villa Road, San Diego 12, Calif. Model 458 preamplifier handles small d-c or a-c signals in the 30 to 2,000 cps range. It extends the sensitivity of precision measuring instruments. Gain is set at a constant value of 100, with gain accuracy of 0.1 percent. Linearity is held within 0.01 percent. Amplifier is chopper stabilized to keep drift below 2 $\mu$v per 24 hr.

**CIRCLE 250 ON READER SERVICE CARD**

## Portable Ohmmeter direct reading

ASSOCIATED RESEARCH, INC., 3777 W. Belmont Ave., Chicago 18, Ill. Precision ohmmeter with accuracy held to ½ percent of mid-scale, advantageous in resistance measurements of leads, grounds, components, point-to-point circuit tests and many other applications. Model 244 is calibrated in 4 ranges, for measurements from 0.05 ohm to 50,000 ohms; model 246 for meas-


# This package can end your worries about silicon processing . . .

Inside this box you'll find doped silicon single crystal slices from Allegheny.

Who needs them? You do . . .

*If* you wish to *increase* production without tying up capital in facilities for slicing, lapping, etching and such.

*If* you'd like to *avoid* being dependent on just one source of supply.

You solve either (or both) of these problems with Allegheny's new service because you get single crystal slices that are *ready for use.*

These slices from vertically pulled or float zoned crystals are doped to range with 99.999% group III and/or V elements. Standard thicknesses from .005" to .020" and diameters from ¼ to 1½ inches.

As for lapping, this we do to your specification. If you wish, we prepare one or both sides for diffusion. Otherwise slices are etched, cleaned and dried before being delivered to you.

Details? We'll provide answers to your questions, promptly.

*NOTE: You'll find that Allegheny devotes its efforts exclusively to producing ultra-pure silicon in every form. You might also be interested in more facts about bulk, billets, rods, doping alloys, seeds or special forms.*

If so, write, wire or phone:

Allegheny Electronic Chemicals Co.
207 Hooker-Fulton Bldg., Bradford, Pa.
252 North Lemon St., Anaheim, Calif.

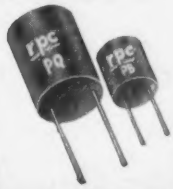
**ALLEGHENY**
**ELECTRONIC CHEMICALS CO.**

*Producers of semiconducting materials for the electronics industry.*

## PRECISION RESISTORS

Type P. wire wound, encapsulated, miniature single ended units for mounting on printed circuit with no support other than wire leads. Resistor element is insulated by Teflon from lead wire, increasing voltage breakdown. Can be operated in ambient temperatures up to 125°C. 7 sizes, from ¼" to ⅜" diam. Rated from .1 to .4 watt. Resistance values to 2 meg. Tolerance from 1% to .05%. Meets requirements of MIL-9-93B.

Other PRECISION WIRE WOUND RESISTORS: Type L with radial lugs, radial or axial wire leads; Type S, hermetically sealed, with axial wire leads.




rpc ®

RESISTANCE PRODUCTS COMPANY

914 S. 13 St. Harrisburg, Pa.

Specialists in manufacturing quality resistors: Precision Wire Wound — High Voltage — High Megohm — High Frequency. Our test equipment and standards for checking and calibrating are matched only by leading laboratories. Write for more information.

## METAL FILM RESISTORS

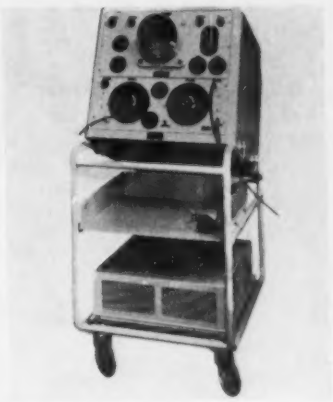
NEW! This precision low noise metal film resistor meets and exceeds requirements with temperature coefficient of plus or minus 50 ppm/°C independent of resistance value. Standard tolerance plus or minus 1 per cent. Type WHM-1.125" long x .406" diam.—is equivalent to MIL Style RN 75, maximum voltage rating 500V. Type WFH-.781" long x .250" diam.—equivalent to MIL Style RN 70, maximum voltage rating 350V.

Enclosed in specially designed hermetically sealed plastic casing (patent pending) to protect precision resistor element.

CIRCLE 168 ON READER SERVICE CARD


urements from 0.01 ohm to 100,000 ohms.

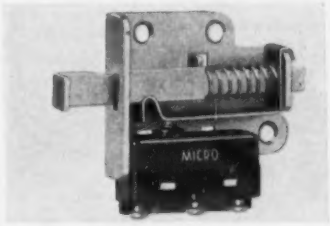
CIRCLE 251 ON READER SERVICE CARD



### Spectrum Analyzer high-frequency

FURZEHILL LABORATORIES LTD., 475 Fifth Ave., New York 36, N. Y. By using the S.510 the frequency/amplitude spectrum of a-m or f-m emissions in the 3-30 mc band may be observed and measured by means of a panoramic presentation on a crt. Dual-persistence screen used permits a range of trace repetition rates from 0.1 to 30 sec. Equipment is suitable for measurement of signal components in a 60 db range and occupying a bandwidth of up to 30 kc. Type S.520 frequency changer which mounts below, and draws its power from the analyzer, extends the range below 3 mc.

CIRCLE 252 ON READER SERVICE CARD




### SPDT Switch high-temperature

MICRO SWITCH, Freeport, Ill. The 17AC1-T subminiature door interlock switch for h-v cabinets, radio, radar, sonar, x-ray, and other electronic cabinets measures 1.182 in. by 1.50 in. by 0.35 in. and weighs 0.32 oz.

CIRCLE 253 ON READER SERVICE CARD


**Reduce rejects and operational failures caused by airborne dirt, dust, lint, abrasives with the**

# HONEYWELL ELECTRONIC AIR CLEANER

When microscopic airborne dirt, dust, lint and abrasives get into precision electric and electronic devices, the results are unusually high reject rates, poor product quality, operational failures. The Honeywell Electronic Air Cleaner will protect your precision components from the damaging action of these airborne spoilers by trapping particles 100 times as small as those stopped by mechanical filters.

**Pays for itself!** Send coupon today to learn how the Honeywell Electronic Air Cleaner soon pays for itself in:

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- **Controlled environment rooms for precision manufacturing, processing and assembly**
- **Switch & relay rooms**
- **Computer rooms**
- **Transmitter rooms**
- **Precision component manufacturing**

MINNEAPOLIS-HONEYWELL
Dept. EL-10-45 Minneapolis 8, Minn.
Please send free copy of Electronic Air Cleaner booklet, "A Close Look at Air-Borne Dirt." We have the following problems:

*Name*

*Company*

*Address*

*City* *Zone* *State*

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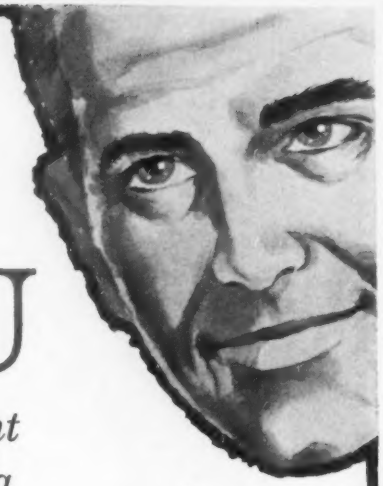

*The importance of being*

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# Literature of

## MATERIALS

**Epoxy Resin.** Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. Processes for insulating transformers to meet the grades of MIL-T-27A with Scotchcast brand epoxy resin are outlined in an 8-page booklet.
**CIRCLE 270 ON READER SERVICE CARD**

## COMPONENTS

**Transformer Specification.** Microtan Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y., has available a short-form interpretation of transformer type designation per MIL-T-27A.
**CIRCLE 271 ON READER SERVICE CARD**

**Computer Transistors.** Texas Instruments Inc., 13500 N. Central Expressway, Dallas, Texas. A mailing piece covers eight commercially available complementary *pnp* and *npn* alloy germanium computer transistors.
**CIRCLE 272 ON READER SERVICE CARD**

**Miniature Clamps.** Sterling Precision Corp., 17 Matinecock Ave., Port Washington, N. Y. A 48-page catalog offers the complete standard stock line of miniature clamps used by the servo computer, electromechanical and electronic industries.
**CIRCLE 273 ON READER SERVICE CARD**

**Magnetic Clutches.** Dynamic Instrument Corp., 59 New York Ave., Westbury, L. I., N. Y., announces a 4-page catalog on its magnetic clutches, brakes and clutch brakes.
**CIRCLE 274 ON READER SERVICE CARD**

## EQUIPMENT

**Meters.** Helipot Division of Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif. A 20-page catalog covers expanded scale a-c and d-c voltmeters, expanded scale frequency meters, and linear scale ammeters. Catalog also points up the company's

# the Week

ability to provide voltage monitoring packages.

**CIRCLE 275 ON READER SERVICE CARD**

**Servo System Simulator.** Servo Corp. of America, 111 New South Road, Hicksville, L. I., N. Y. How to design, breadboard, and analyze servo systems rapidly, without need for fabrication of expensive intermediate prototypes, is detailed in a comprehensive report describing the Servolab servo system simulator.

**CIRCLE 276 ON READER SERVICE CARD**

**Shock and Vibration Control.** Barry Controls Inc., 700 Pleasant St., Watertown 72, Mass. Bulletin 59-05 contains shock and vibration control data for military applications, machinery mounts, commercial applications and test equipment.

**CIRCLE 277 ON READER SERVICE CARD**

**Carrier Modulation Analyzer.** Boonshaft and Fuchs Inc., Hatboro Industrial Park, Hatboro, Pa. Technical bulletin 91411 describes the theory and operation of the visual phase sensitive detector, a test instrument used in the performance evaluation of a-c servo amplifiers and mechanisms.

**CIRCLE 278 ON READER SERVICE CARD**

## FACILITIES

**Solder Joint Reliability.** Dressen-Barnes Corp., 250 No. Vinedo Ave., Pasadena, Calif. An illustrated comprehensive report tells how failure in electronic equipment can be reduced appreciably and reliability improved by using a carefully planned, clearly defined, and illustrated checkout procedure for solder joint checks.

**CIRCLE 279 ON READER SERVICE CARD**

**Receiver Sensitivity.** HRB-Singer, Inc., Science Park, State College, Pa., has available a receiver noise figure and sensitivity slide rule. To obtain one write on company letterhead.

- Simulates Mechanical Problems, Processes and Conditions
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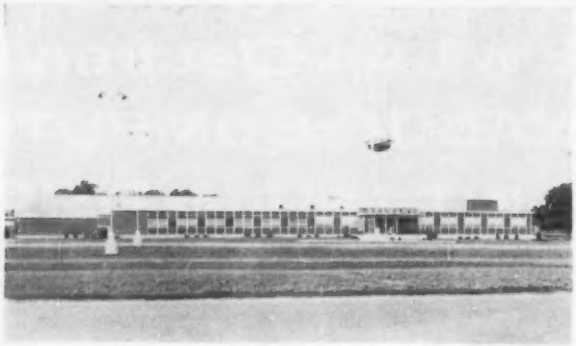

# Sylvania: 22 Plants in Pa.

MUNCY, PA.—A new plant for custom production of computer components, assemblies and coils has just been opened here by Sylvania Electric Products Inc., subsidiary of General Telephone & Electronics Corp. The 77,000-sq-ft facility is Sylvania's 22nd plant in Pennsylvania.

The new Computer Products Operations plant employs more than 600. It replaces leased facilities in nearby Williamsport, where only 250 were working at the end of 1958.

Sylvania President Robert E. Lewis, and a senior vice president, Howard L. Richardson, were key speakers at the dedication ceremony. Lewis called the new plant "one of the most important units in the nation devoted exclusively to the custom production of computer components, assemblies and coils." Richardson pointed out Sylvania has a similar plant in Santa Cruz, Calif., to serve the West Coast electronics market.

Lewis predicted the electronic data processing market will amount to more than $1 million this year and double itself by 1965.

The new plant here supplies leading computer manufacturers, diversified electronics companies throughout the country, and the armed services.

Sylvania now has 45 plants and 22 laboratories in 39 communities in 13 states. The company's total productive area is about 6.8 million sq ft.

## Barmat Heads New GI Division

APPOINTMENT of Melvin Barmat, thermoelectric physicist-engineer, as manager of the newly-created Thermoelectric Division of General Instrument Corp. is announced. He previously had been with the Martin Co. where he was project manager for Snap III, the five-pound atomic thermoelectric generator unveiled by the AEC at the White House earlier this year.

## Bradley Corp. Adds to Staff

THREE appointments recently announced by Bradley Semiconductor Corp., New Haven, Conn., continue a series of changes made during the past few months in what shapes up as a general revamping of staff and production facilities.

Edward C. Keough, applications engineer, has been named to the newly created post of assistant sales manager. He will assist William J. Gagnon, sales vice president, in coordinating new engineering developments with the broadening sales program.

Robert Carr joins the Bradley organization as divisional manager in charge of the Silicon Division. He has served as an engineer with Proctor and Gamble, U. S. Steel, and most recently in charge of semiconductor design in the rectifier department at General Electric.

Robbie H. Glass is named production engineer in charge of the Selenium Division at Bradley. He was in the research department of the Lynchburg (Va.) Foundry Co., and later in the rectifier division of General Electric as component engineer.

## Appoint Willits Department Head

AIRPAX ELECTRONICS, INC., names C. L. Willits as head of the Quality Control Department of the Seminole Division in Ft. Lauderdale, Fla.

Willits was previously with the Bendix Aviation Corp., Davenport, Iowa, where he was employed as senior project engineer and Bendix Pacific, as design engineer. Prior to his employment with Bendix he spent 3 years in Europe as engineering representative for Mackay Radio, a division of International Telephone and Telegraph Corp.

As head of the Quality Control Department, Willits is responsible for insuring conformance of components and systems to rigid specifications for industrial products as

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| C 2 | 6.3 | 171 | .44" |
| C 22 | 5.5 | 184 | .44" |
| C 3 | 5.4 | 197 | .64" |
| C 33 | 4.8 | 220 | .64" |
| C 4 | 4.6 | 229 | 1.03" |
| C 44 | 4.1 | 252 | 1.03" |

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well as for the ever expanding missile and aircraft projects being handled at the plant.

## Gattoline Joins Daystrom

APPOINTMENT of John J. Gattoline as sales manager of Daystrom Transicoil, Division of Daystrom, Inc., is announced. He was formerly vice president of E. W. Larrabee, Inc., design and development engineers. During his sales and engineering career, Gattoline has been associated with Hillyer Instrument Co., Inc., and W. L. Maxson Corp.

Daystrom Transicoil designs and manufactures servo and synchro mechanisms and components, largely for the missile industry. Company headquarters and plant are in Worcester, Montgomery County, Pa.

## Organize New Corporation

CONLEY ELECTRONICS CORP. is a new corporation in Skokie, Ill., organized for the development and merchandizing of electronic products for the consumer, industrial and military markets.

The corporation now has three divisions: Waters Conley Co., Inc., Rochester, Minn., portable phonograph manufacturer; the Fidelivox Division of Skokie, Ill., which develops and manufactures automatic tape reproducers; and the Fidelipac

Division of Toledo, Ohio, which recently announced the volume introduction of a continuous play one reel magazine.

## Promote Two At Bell Labs

KENNETH G. MCKAY has been elected vice president in charge of systems engineering of Bell Telephone Laboratories, New York City. A research physicist, McKay has been associated with electronic, semiconductor and solid state research and development programs at the Labs since 1946.

Morgan Sparks has been named director of developments of components and solid state devices, succeeding McKay. Previously Sparks served as director of transistor development.

## News of Reps

Four new engineering sales reps have been named by Tally Register Corp., Seattle, Washington.

**Pivan Engineering,** with headquarters in Chicago, covers Illinois, Indiana, eastern Iowa, and eastern Wisconsin. **Dayton Associates,** with offices in Cincinnati and Dayton, covers Ohio and western Pennsylvania. **Wild Associates,** which has previously represented the firm throughout the Middle Atlantic States, has established a Boston office to cover the New England States. **Engineering Products Associates** of St. Paul services Minnesota, western Wisconsin, western Iowa, and North and South Dakota.

**Wallace-Gluck Co.** of Dallas, Texas, has been appointed sales rep for Perkin Engineering Corp., Electronic Division, El Segundo, Calif. Territory includes Louisiana, Arkansas, Oklahoma, and all of Texas except El Paso.

**James R. Bunn,** a staff engineer in the **Neely Enterprises** Albuquerque office since 1957, has been promoted to field engineer. In his new position he will headquarter at the firm's Las Cruces office.


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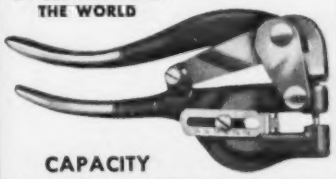

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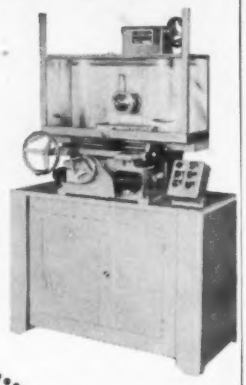

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# COMMENT

### Western Growth

It was interesting to read, in the Aug. 7 issue of ELECTRONICS ("Technical and Business Growth in West," p 103), your story on western industry. I was disappointed, however, to note that the Albuquerque-Santa Fe-Los Alamos area was not included.

There are more than fifteen firms in this area, even excluding Sandia Corp. and the Los Alamos Scientific Laboratory. Since a great portion of the work carried on by these laboratories is in the electronics area I feel they should be included. If this were done, the number of firms would be at least as large as that listed for Denver, and the number of employees would be considerably larger.

You may also be interested in the academic research underway at the University of New Mexico. In electrical engineering we are concerned particularly with problems of radio propagation, including radar return from the ground; submarine communications; and a classified study having to do with rocket exhausts. In addition, we are active in the semiconductor area, are developing transistor distributed amplifiers, applying information theory to distance-measuring systems, and developing a kit-style digital computer.

Our physics department is active in magnetohydrodynamics. It has the world's largest scintillation counter. The department is studying cosmic rays, ozone content of upper and lower atmosphere, and other topics.


R. K. MOORE
UNIV. OF NEW MEXICO
ALBUQUERQUE, N. M.


### Wrong Head

I was pleased to see my article "Solders for Nuclear and Space Environments" in the Sept. 4 issue (p 50).

I am writing to correct one error which appeared in the article byline. I am head of the materials and devices research section of the research and analysis department here, and although I appreciate

your promoting me to head of the whole department, I believe a correction might be in order.

David Ellis is the head of research and analysis department at Litton Industries.

ALVIN B. KAUFMAN
LITTON INDUSTRIES
BEVERLY HILLS, CALIF.

**Apologies to all hands.**

### Names in Error

Concerning my article ("Locked Oscillator for Color Tv," in Research and Development, p 90, Sept. 25), please note carefully that Brookhaven National Laboratory was only my summer mailing address. No reference to Brookhaven National Laboratory should appear with the article.

The circuit was developed by me while I was a member of the technical staff of RCA Laboratories Division, and should be so identified with the article.

My present affiliation is with the Department of Electrical Engineering, The City College . . .

MARVIN METH
THE CITY COLLEGE
NEW YORK

**We regret that author Meth's letter arrived too late for us to make the necessary correction. We also made another error in giving his name as I. N. Meth instead of M. Meth.**

### Kudos

Here in Latin America, we regard ELECTRONICS as an authority . . .

One impressive trend I've personally noticed is how, without affecting the quality of your technical features, you've been building up the level of the departments in the back of the magazine. It's getting so that Production Techniques and Components & Materials are almost more interesting than the rest of the magazine, especially here where sophisticated techniques and advanced materials are always late arriving. Research & Development is another department that we all read avidly.

STEWART FABREGA
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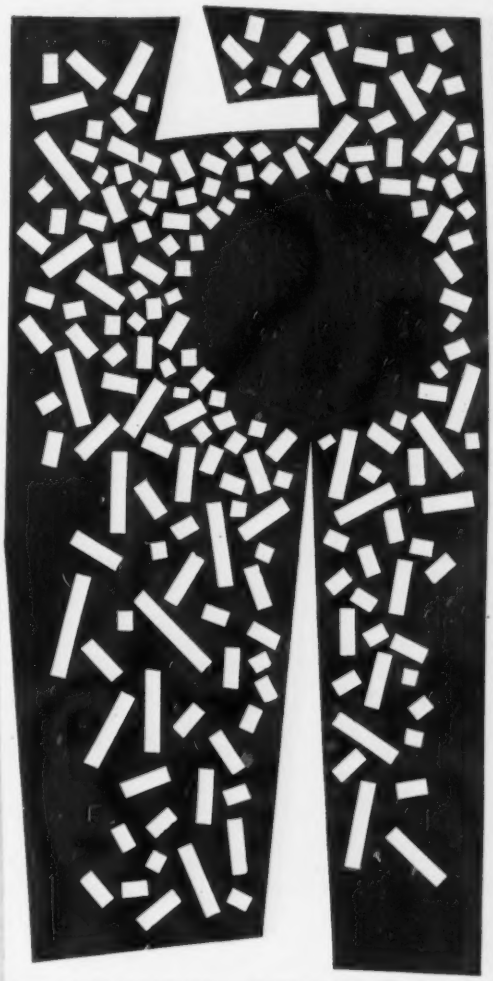
Original painting by Oli Sihvonen, Taos, N. M.



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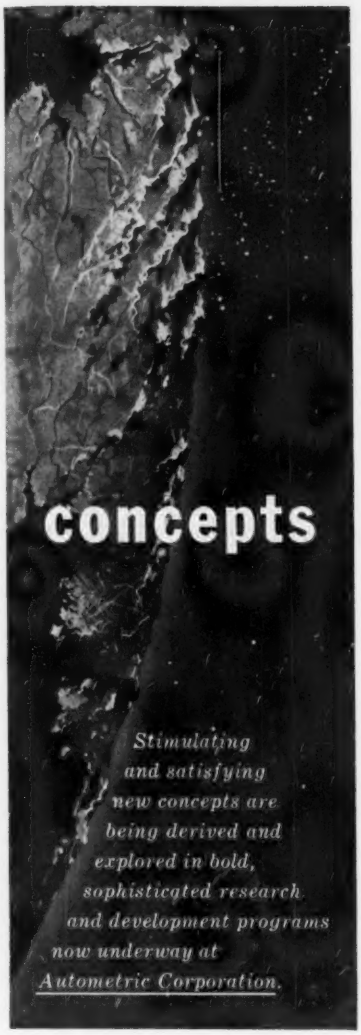
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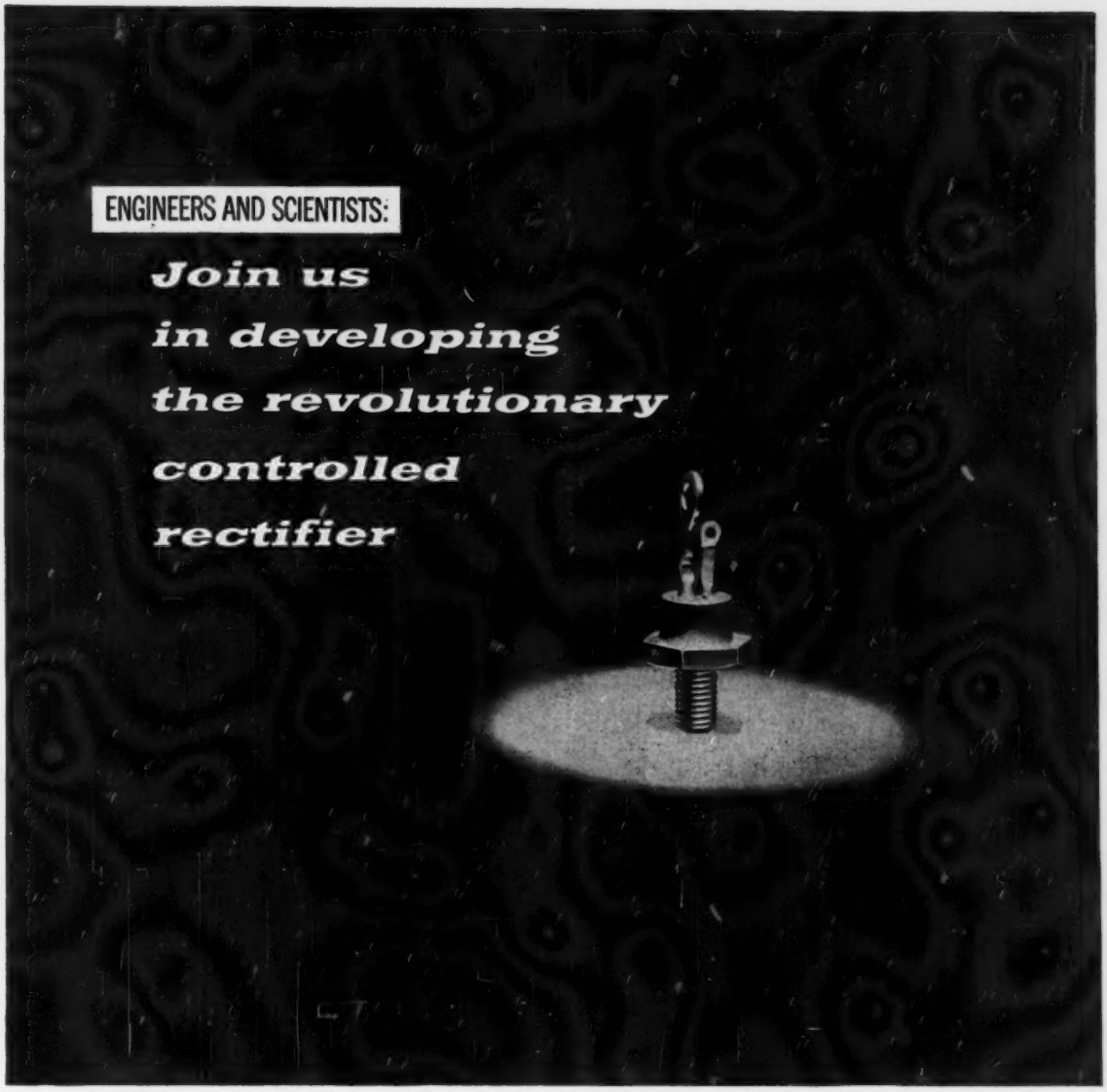


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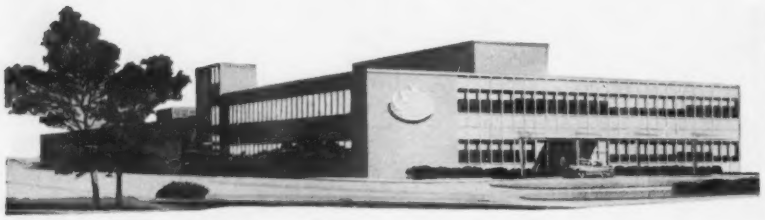

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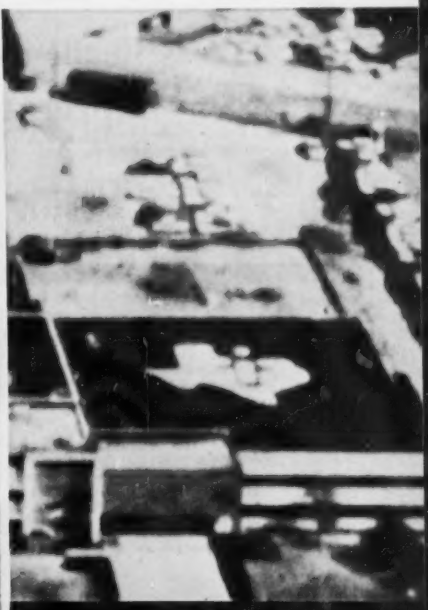

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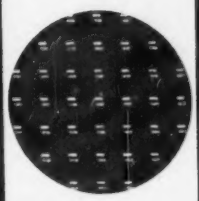

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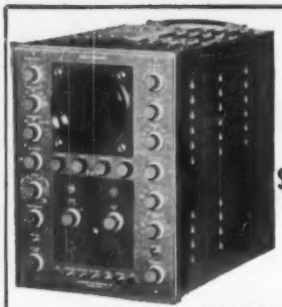

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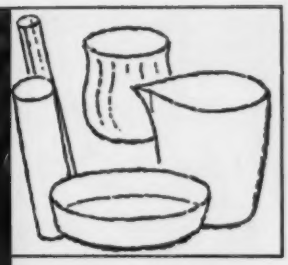

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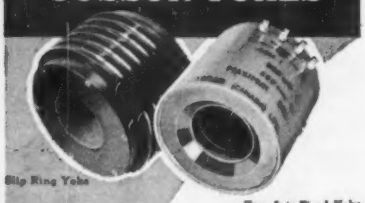

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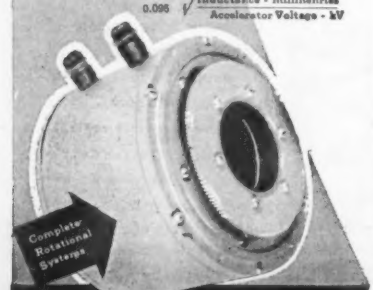


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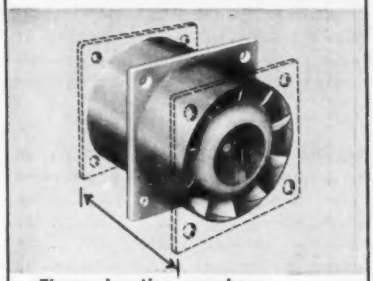
# THE STANDARD 2" BLOWER you've been waiting for!

Dean & Bensons

# POWAIR

## New HP & HF Series

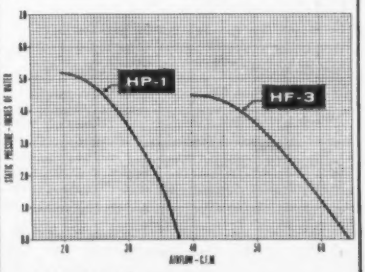


Flange location anywhere

1 Lightweight Aluminum alloy construction for clean aerodynamic surfaces and rigid construction.

2 Square or round flange located at your option, anywhere along the blower housing.

3 Slip out AC or DC motor allows for easy and inexpensive maintenance without replacing entire unit.




**POWAIR** performance opens the door to a tighter system design for weight and size reduction.

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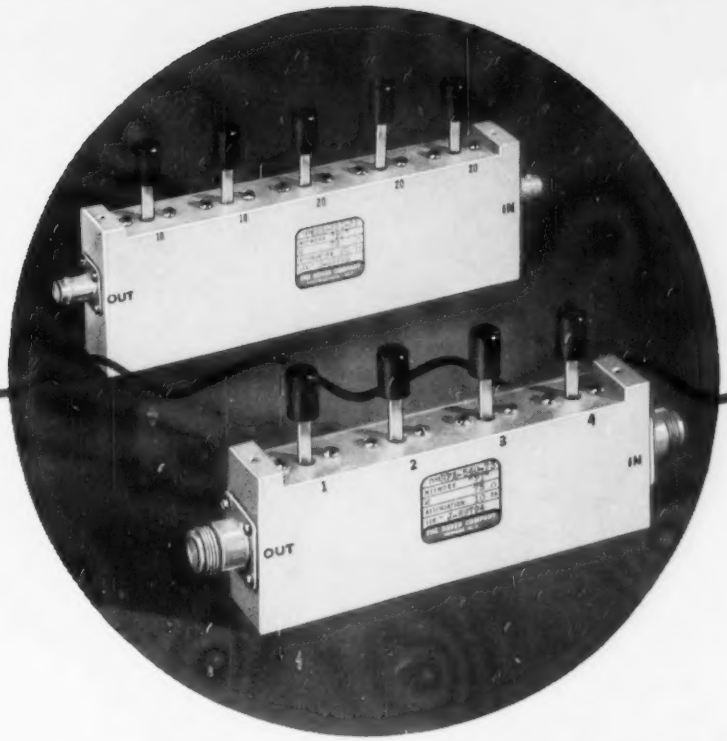



# FOR ACCURATE ATTENUATION OVER A WIDE FREQUENCY RANGE...

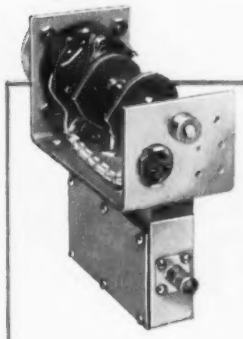
## *RF Attenuators by* DAVEN

These units are used in signal generators, wide-band amplifiers, pulse generators, field intensity meters, micro-wave relay systems, and repeater stations. They find application as laboratory standards, test equipment, and for checking out all types of instruments.

Daven RF Attenuators are available, in combination, with losses up to 120 Db in two Db steps; or 100 Db in one Db steps. Due to their internal circuitry and construction, they have a **zero insertion loss** over the **frequency range from DC to 225 megacycles.**

Standard impedances are 50 and 73 ohms, with special impedances available on request. Resistor accuracy is within ±2% at DC. An unbalanced circuit is used which provides constant input and output impedance. The units are supplied with either UG-58/U or UG-185/U receptacles or Coaxial lead terminations. Individual units with single-section cavities can be obtained.

Many of these types are available for delivery from stock.



Solenoid actuated RF Attenuators are also available in various decibel combinations and any number of steps up to 5.

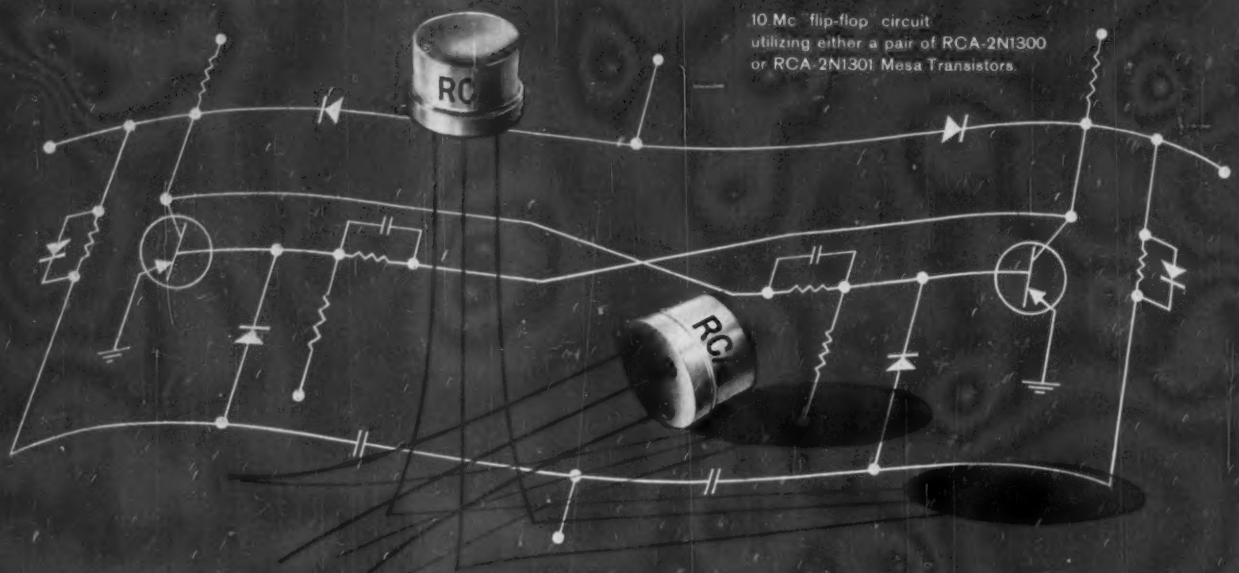
| TYPE | LOSS | TOTAL Db | STANDARD IMPEDANCES |
|---|---|---|---|
| RFA & RFB 540 | 1, 2, 3, 4 Db | 10 | 50/50Ω and 73/73Ω |
| RFA & RFB 541 | 10, 20, 20, 20 Db | 70 | 50/50Ω and 73/73Ω |
| RFA & RFB 542 | 2, 4, 6, 8 Db | 20 | 50/50Ω and 73/73Ω |
| RFA & RFB 543 | 20, 20, 20, 20 Db | 80 | 50/50Ω and 73/73Ω |
| RFA & RFB 550 | 1, 2, 3, 4, 10 Db | 20 | 50/50Ω and 73/73Ω |
| RFA & RFB 551 | 10, 10, 20, 20, 20 Db | 80 | 50/50Ω and 73/73Ω |
| RFA & RFB 552 | 2, 4, 6, 8, 20 Db | 40 | 50/50Ω and 73/73Ω |

Other Db loss combinations are available.

*Write for complete information*

THE DAVEN CO.
Livingston, N. J.

WORLD'S LARGEST MANUFACTURER OF ATTENUATORS



10 Mc flip-flop circuit utilizing either a pair of RCA-2N1300 or RCA-2N1301 Mesa Transistors.

# RCA-2N1300 and 2N1301

## LOW-COST MESA COMPUTER TRANSISTORS

*Now in quantity production . . . and available!*

RCA-2N1300 and 2N1301 Germanium P-N-P Mesa Transistors offer these 10 major benefits to designers of switching circuits. And they're ready for you now!

- rugged Mesa structure—permits extremely small base width to insure top performance at high frequencies
- fast switching times with low values of base input current—made possible by high frequency response and low total stored charge
- high current gain—permits high fan-out ratios (number of paralleled similar circuits per driver-stage output)
- high breakdown voltage and punch-through voltage ratings—the result of the diffusion process
- high power dissipation—150 milliwatts at 25°C—aids in the design of reliable circuits
- high current ratings—improve overall system speed
- rugged overall design—units have unusual capabilities to withstand severe drop tests and electrical overloads
- electrical uniformity—a result of the diffused-junction process used by RCA in the manufacture of Mesa Transistors
- especially well suited for use at pulse repetition rates up to 20 Mc
- exceptionally well suited to applications in saturation-type switching circuits.

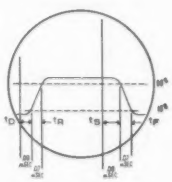
**Information on RCA-2N1300 and 2N1301 Low-Cost Mesa Transistors is available from your RCA Field Representative. For technical data, write RCA Commercial Engineering,**

Section I-19-NN-3, Somerville, N. J.

| RCA TYPE | Maximum Ratings* Absolute-Maximum Values | | | | | | Characteristics: Common-Emitter Circuit, Base Input Ambient Temperature at 25° C | | |
|---|---|---|---|---|---|---|---|---|---|
| | Collector-to-Base Volts | Emitter-to-Base Volts | Collector Milli-amperes | Transistor Dissipation—mw | | | Minimum DC Current Gain | | Gain Bandwidth Product• Mc |
| | | | | at 25°C | at 55°C | at 71°C | at collector ma = −10 | at collector ma = −40 | |
| 2N1300 | −13 | −1 | −100 | 150 | 75 | 35 | 30 | — | 40 |
| 2N1301 | −13 | −4 | −100 | 150 | 75 | 35 | 30 | 40 | 60 |

*Maximum collector-to-emitter voltage rating = −12 volts

• For collector ma = −10 and collector-to-emitter volts = −3.



Oscilloscope wave form shows typical delay, rise, storage, and fall times achieved with 10-ma inverter circuit utilizing the RCA-2N1301 MESA TRANSISTOR.

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